ACCO

Material Handling Group

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60-1

WRIGHT®

Work-rated **SELECTION GUIDE**
FOR MASTER CATALOG
SECTIONS 20, 30, 31,
32, 33, 34 & 36

Wright-Way® and *Wright* wire rope electric hoists are work-rated according to their design capabilities to provide the user with maximum performance for minimum price with low maintenance and downtime costs.

Getting the most from your hoist investment is simply a matter of evaluating the work the hoist must perform, then buying the hoist that does that work most efficiently. This Hoist Selection Guide can eliminate costly over- or under-specifying by helping you quickly select the hoist best matched to your particular service needs.

Wright hoists are classified in three service categories:

H2 Normal-Duty
H3 Heavy-Duty
H4 Severe-Duty

The data contained in the Selection Guide will allow you to identify the work-rated category that is right for your job — H2, H3, or H4,— as indicated on each hoist date page.

Follow this three step instruction procedure for accurate hoist selection.

Step **1** Determine the applicable **load distribution**.

General load distribution or Extreme load distribution

Step **2** Determine the proper **Selection Graph**

Graph I, II, III or IV.

Step **3** Determine the proper **work-rated service** category from the selected graph.

H2 Normal duty,   **H3** Heavy duty,   or   **H4** Severe duty

Step 1 Determine the applicable **load distribution** — General or Extreme.

These terms define the type of load conditions which will occur when the hoist is in use.

GENERAL LOAD DISTRIBUTION

In this type of service, half the time the hoist is operating without load. The load is lifted and carried to the location, then the hoist is returned without load.
Most hoisting applications fall into the general category.

EXTREME LOAD DISTRIBUTION

In this type of service the load is handled by the hoist more than half its operating time. Any application which includes an attachment (grab, bucket, etc.) falls under this category.

Attachments such as slings, that are less than 5% of the name plate rating are not considered as a load.

Step 2 Determine the proper **Selection Graph**

IF THE HOIST SERVICE YOU ARE CONSIDERING IS THE "GENERAL LOAD DISTRIBUTION", FOLLOW STEPS A THRU E.

A. Determine maximum load handled in the operation.

B. Select the nameplate rating required to handle that load. The left column of the nameplate - capacity load chart on this page indicates nameplate ratings available. If the maximum load falls between nameplate ratings, always advance to the next higher capacity. (Example: for 2.1 ton maximum load select 3 ton nameplate rating.)

C. Identify **capacity load,** right column of chart.
(A capacity load is any load between 80% and 100% of the nameplate rating of the hoist. For example, for 3-ton rated hoist, capacity loads are all loads between 2.4 and 3 tons.)

D. Determine **total number of lifts.** A lift is one complete raise and lower operation of the hoist. All lifts must be considered whether fully loaded, partially loaded or those with no load.

E. Determine **load probability.** This is a decimal figure indicating the amount of time that capacity loads will be handled by the hoist. For example:

2	Lifts at **Capacity Loads**
10	Lifts **Less than Capacity Loads**
12	Lifts with **No Load**
24	Total lifts

$$\text{Load Probability} = \frac{2 \text{ Lifts at } \textbf{Capacity Load}}{24 \textbf{ Total Lifts}} = .08$$

F. Pick applicable Selection Graph.

- If probability of capacity load is 0.5, use Graph I.

- If probability of capacity load is less than 0.5 but equal to or greater than 0.2, use Graph II.

- If probability of capacity load is less than 0.2 but greater than 0.05, use Graph III.

- If probability of capacity load is equal to or less than 0.05, use Graph IV.

IF THE HOIST SERVICE YOU ARE CONSIDERING IS THE "EXTREME LOAD DISTRIBUTION", FOLLOW STEPS AA THRU CC.

AA. Determine **maximum load** including the weight of any attachment (grabs or slings) used in the operation.

BB. Select the nameplate rating required to handle the load. The left column of the nameplate - capacity chart on this page indicates nameplate ratings available. If the maximum load falls between nameplate ratings, always advance to the next higher capacity. (Example: for 2.1 ton maximum load select 3 ton nameplate rating.)

CC. Pick applicable Selection Graph.

- If majority of loads or weight of attachment is equal to or greater that 50% of nameplate rating (load magnitude equal to or greater than 0.5) of hoist use Graph I.

- If majority of loads or weight of attachment is less than 50% of nameplate rating (load magnitude less than 0.5) of hoist use Graph III.

NAMEPLATE — CAPACITY LOAD CHART

Nameplate Rating Tons	Capacity Load Tons
1/2	0.4 - 0.5
1	0.8 - 1
1-1/2	1.2 - 1.5
2	1.6 - 2
3	2.4 - 3
4	3.2 - 4
5	4 - 5
6	4.8 - 6
7-1/2	6 - 7.5
10	8 - 10
15	12 - 15
20	16 - 20

Step 3 Determine the proper **work-rated service** category from the graph.

Following the instructions on the preceding page, you have now selected Graph I, II, III, or IV.

To use the graphs for selection of the correct work-rated hoist classification, you need know only three factors:

A. Lifting speed (feet per minute)

This figure must be calculated for critical applications on the basis of individual service requirements. If it is not critical, use the most popular speeds of 20 to 30 feet per minute.

B. Lifts per hour

This figure can be determined by estimating the number of **times per hour** that the hoist must **lift a load.**

C. Vertical distance of lift

Estimate the height the load must be lifted. If lifting to varying heights is required, use an average of the different heights.

YOU NOW ARE READY TO SELECT THE WORK-RATED SERVICE CATEGORY FROM THE PROPER GRAPH.

Just follow these procedures.

1. Locate the lifting speed required in lower left hand corner of graph.

2. Locate LIFT PER HOUR figure opposite preselected lifting speed.
   Enter graph vertically at this point.

3. Locate TYPICAL LIFTING DISTANCE (FEET) figure at left side of graph. Enter graph horizontally at this point.

THE POINT WHERE THE HORIZONTAL AND VERTICAL LINES INTERSECT WILL INDICATE THE WORK RATED HOIST SERVICE YOU NEED:

H2 Normal duty
H3 Heavy duty
H4 Severe duty

When you arrive at your duty category (H2 or H3) and the specific hoist is not available in the category indicated, (H2 or H3) move up to the next higher category (H2 to H3; H3 to H4).

If your duty requirement is H4 and the specific hoist indicated is not available in H4 or if your lines intersect in the white area of the graph, ask for assistance from your Acco representative.

Consult your "Wright distributor if the following conditions are exceeded.

	H2	**H3**	**H4**
● Starts and stops per hour	300	300	300
● Operating time minutes per hour	8	15	30

● If your lowering distance exceeds 40 feet.

NOTES:

GRAPH I 60-4

TYPICAL LIFTING DISTANCE (FEET)

60
55
50
45
40
35
30
25
20
15
10
5
0

H4

H3

H2

Note: Repetitive operations that continue longer than 8 hr. should be reviewed with Wright representative.

10 FPM		5	10	15	20	25	30
15 FPM	5	10	15	20	25	30	35	40	45
20 FPM	5	10	15	20	25	30	35	40	45	50	55	60
30 FPM	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
40 FPM	5	10	20	30	40	50	60	70	80	90	100	110	120
60 FPM	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
80 FPM	10	20	40	60	80	100	120	140	160	180	200	220	240

LIFTS PER HOUR

GRAPH II 60-5

TYPICAL LIFTING DISTANCE (FEET)

60
55
50
45
40
35
30
25
20
15
10
5
0

H4
H3
H2

10 FPM		5		10		15		20		25		30
15 FPM	5		10	15		20	25		30		35	40		45
20 FPM		5	10	15		20	25	30		35	40		45	50		55		60
30 FPM		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
40 FPM	5	10		20		30		40		50		60		70		80		90		100		110		120
60 FPM		10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
80 FPM		10	20		40		60		80		100		120		140		160		180		200		220		240

LIFTS PER HOUR

GRAPH III   60-6

TYPICAL LIFTING DISTANCE (FEET)

H4

H3

H2

10 FPM		5		10		15		20		25		30
15 FPM		5	10	15	20	25	30	35	40	45
20 FPM		5	10	15	20	25	30	35	40	45	50	55	60
30 FPM		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
40 FPM		5	10	20	30	40	50	60	70	80	90	100	110	120
60 FPM		10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
80 FPM		10	20	40	60	80	100	120	140	160	180	200	220	240

LIFTS PER HOUR

GRAPH IV

60-7

TYPICAL LIFTING DISTANCE (FEET)

H4

H3

H2

| 10 FPM | 5 | 10 | 15 | 20 | 25 | 30 |
15 FPM	5	10	15	20	25	30	35	40	45
20 FPM	5	10	15	20	25	30	35	40	45	50	55	60
30 FPM	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
40 FPM	5	10	20	30	40	50	60	70	80	90	100	110	120
60 FPM	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
80 FPM	10	20	40	60	80	100	120	140	160	180	200	220	240

LIFTS PER HOUR

EXAMPLE # 1

4.5 Ton bundles of steel tubing are unloaded from a receiving truck and placed into a storage area. Six bundles are unloaded every hour; 1 shift per day. Chain slings are used to handle the loads. The loads are lifted from the bed of the truck to a maximum height of 10 feet and transported to the storage area, lowered, released. The hoist is then returned to the truck to repeat this operation. User desires hoist speed of 15 FPM single speed.

EXAMPLE # 2
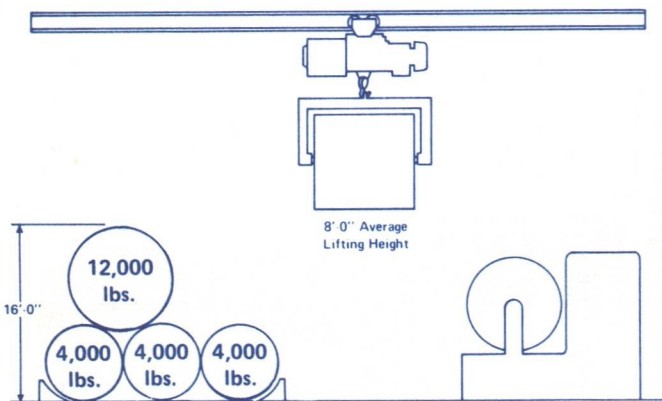
This hoist handles paper rolls from a storage area to the roll processing area. Rolls vary in size and weight from 4,000 lbs. min. to 12,000 max. A roll handling device is used to grab the loads and is always on the hoist. This grab weighs 2,100 lb. 60% of the rolls weigh 4,000 lb. and 20% weigh 12,000 lbs. The rolls are stacked to a height of 16 feet, the average lift height is determined to be 8 feet. The rolls are transported from the storage area to a process area 4 times per hour. The user would like a hoist speed of 20 FPM.

STEP   CONCLUSION

1 "**General** Load distribution" category is selected since the hoist returns without load.

2A "Maximum load" is 4.5 tons.

2B "Nameplate rating" is 5 ton.

2C "Capacity load" is any load between 4 & 5 tons.

2D Since there are six lifts with load and six return lifts without load, then the total number of lifts is twelve.

2E There are six lifts at capacity load (4 to 5 tons) then the "load probability" is 6/12 = **0.5.**

2F 0.05 "Load probability" indicated selection of Graph I

3 On Graph I Tracing the 15 FPM at 6 lifts per hour to a lifting distance of 10 feet indicates an H3 hoist is required.

CONCLUSION

1 "Extreme Load Distribution" category is selected since the 2100 lbs. grab is always on the hook when the hoist is operating.

2AA The "maximum load" to be lifted is (12,000 lb. roll plus 2,100 lb. grab) 14,100 lbs.

2BB "Nameplate rating" of hoist would be 7½ tons.

2CC Majority of loads are (4,000 lbs. plus 2,100 lbs.) 6,100 lbs. which is less than 50% of "nameplate rating" (15,000 lbs.) therefore graph III is selected.

3 On Graph II tracing the 20 FPM at 8 lifts per hour to a working height of 8 ft., indicates an H2 hoist is required.

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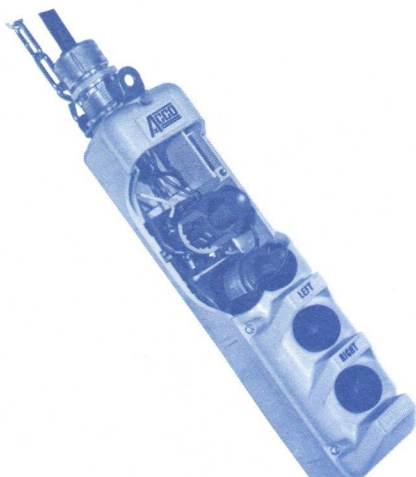
Wright pendant-mounted push button stations are molded, impact resistant *Lexan®* units designed for high abuse, low maintenance, control of overhead cranes and hoists. They are available in 2 button variable speed and 4, 6 or 8 button single speed, 2 speed and variable speed. Two button single speed and two speed station of this style is available on application.

Wright pendant mounted push button stations are momentary contact type. Applications requiring maintained contact type buttons must be referred to the regional sales offices for pricing or availability.

CONSTRUCTION FEATURES

LIGHTWEIGHT, RUGGED HOUSING
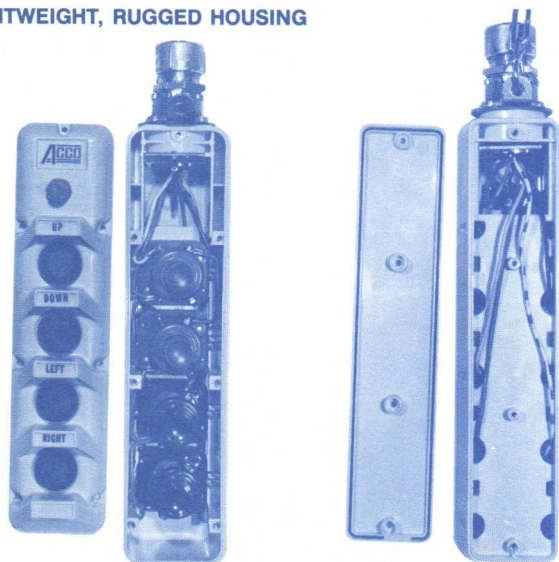
The resilient, lightweight, molded *Lexan®* construction protects internal switches and connectors from accidental damage caused by impact. The smooth edged lightweight construction also gives protection against damages to personal goods or equipment caused by swinging pendant.

DOUBLE INSULATED
Lexan® pendant body and plastic push button element housing combine to make double insulated unit.

HIGH VISIBILITY YELLOW
MEETS OSHA REQUIREMENTS
AC AND DC RATED

SEAL ENCLOSURE
The molded *Lexan®* front and back covers seal with a gasket to pendant body, and neoprene caps seal the openings for the push button plungers to block the entry of dirt, water, oil or dust. This standard sealed button enclosure meets NEMA type 3 dust-tight, rain-tight and sleet (ice)-resistant, and NEMA type 4 water-tight requirements for outdoor installations, and NEMA type 12 dust-tight and drip-tight indoor installations.

EASY ONE HAND OPERATION
Compact 3¼″ x 4⁷⁄₁₆″ enclosure fits hand easily. Small multiple faced body of the pendant station is shaped to fit comfortably in the operator's hand, even when wearing gloves, and buttons are positioned for easy, one hand selection and operation. Push button caps are very pliable so as not to interfere with operation of the push buttons themselves.

LARGE OPERATING BUTTONS
Large finger contoured buttons are engineered for easy, fast access.

SMOOTH BUTTON OPERATION
Light smooth pressure is required for operation. Multi speed push button element requires only ¾ inch for full operation.

CLEAR MARKINGS
A series of easy to read legend plates identify each button function. Button markings are recessed in integrally molded button guards.

EASY REPLACEMENT OR CHANGE
Each push button element is an individual self contained unit. The button elements are positioned on pins held in position by spring clips and the clamping action of the cover, and cushioned by a flange or hood to prevent element damage from shock. This design makes button element replacement and circuit change a simple, easy operation.

ARRANGEMENT FLEXIBILITY
All types of push button elements are interchangeable in the same housing.
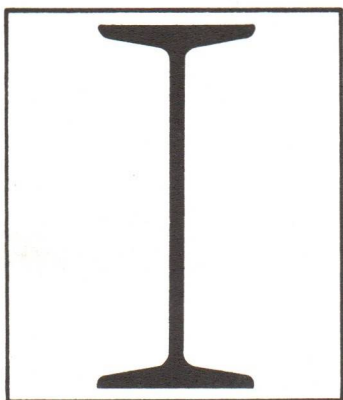
PROTECTED BUTTONS
Raised, curved guards, on the shaped *Lexan®* cover, protect the buttons from bumps or inadvertent operation.

STRESS RELIEF
The conductor cable is attached to the pendant body with cord grip and neoprene grommet that provides an effective seal and securely holds the cable. A chain strain-relief removes strain from the electric conductor.

SINGLE SPEED PUSH BUTTON ELEMENT

The single speed pushbutton element has both normally open and normally closed contacts within its molded phenolic plastic housing. Only the terminal screws for external connections are exposed. The movable contact member is a bridge type with silver alloy contacts, and is mounted on the button between springs to provide contact pressure. A spring returns and holds the button in the off position when not in use.

2 SPEED AND 5 SPEED PUSH BUTTON ELEMENTS

2 Speed   5 Step Variable Speed

The 5 step variable speed pushbutton element requires a depression of only ¾ inch for full operation, with a movement of ⅛ inch between each speed point. It is enclosed in a molded alkyd plastic housing, and only the terminal screws for external connections are exposed. The movable contact member is an assembly of six copper-carbon brushes, radially mounted in an alkyd molding fastened to the button. The pushbutton circuit is made in steps as the button is pressed, moving the brushes down to contact in successive order, the phosphor bronze segments of varying length mounted in grooves in the barrel of the housing. Beryllium copper springs exert a contact pressure on the brushes, and two return springs maintain the button in the off position. Design of the 2-speed pushbutton element is the same as that of the multi-speed, but contact variations are made to provide the required operating positions.

OPTIONAL SWITCHES AND LIGHTS

Toggle switches, selector switches and oiltight indicator lights are available as optional equipment.

DIMENSIONAL DATA

6

4

2-1/2

B

A

3-1/4

1-5/8

1-7/16

4-7/16

Top View

2-1/4   2 Buttons 9-3/16

4 Buttons 13-11/16

2-1/4   6 Buttons 18-3/16

2-1/4   8 Buttons 22-11/16

2-3/8

"A" optional toggle switch, oiltight light
"B" optional "T" junction box, 4 x 6 x 3, maximum 1-toggle switch and 2-oiltight lights or selector switch or pushbutton.
All dimensions in inches and millimeters unless otherwise noted.

STANDARD MARKINGS	FUNCTION	STANDARD LEGEND
	POWER	ON
		OFF
	HOIST	UP
		DOWN
	TROLLEY	RIGHT
		LEFT
	BRIDGE	FORWARD
		REVERSE

8 Buttons
ON
OFF
UP
DOWN
RIGHT
LEFT
FWD
REV
POWER
HOIST
TROLLEY
BRIDGE

6 Buttons
ON
OFF
UP
DOWN
FWD
REV
POWER
HOIST
BRIDGE

ON
OFF
UP
DOWN
RIGHT
LEFT
POWER
HOIST
TROLLEY

4 Buttons
UP
DOWN
RIGHT
LEFT
HOIST
TROLLEY

ON
OFF
UP
DOWN
POWER
HOIST

2 Buttons
UP
DOWN
HOIST

SPECIAL PURPOSE LEGEND MARKINGS

OPEN	OVERLOAD
CLOSE	BY-PASS
LIGHTS	UNLOCK
LIFT	LOCK
DROP	SIREN
HORN	

Material Handling Group

Structural Beam Design Guide and Selection Chart for Overhead Crane Runway System

WRIGHT®
Overhead Cranes

INFORMATION CONTAINED IN THIS 2ND EDITION IS BASED ON NEW, REVISED W SHAPE, S20 SHAPE, AND S24 SHAPE PROFILES, HAVING AN EFFECTIVE ROLLING OR AVAILABILITY DATE OF 1 SEPTEMBER 1978. THEREFORE, THIS INFORMATION IS NOT APPLICABLE FOR STRUCTURAL SHAPES ROLLED IN ACCORDANCE WITH PREVIOUS OBSOLETE PROFILE STANDARDS. FOR IN-FORMATION ON OBSOLETE STRUCTURAL SHAPES, REFER TO THE 1ST EDITION OF THIS GUIDE, REFER TO THE REFERENCES LISTED THROUGHOUT THIS PUBLICATION, OR CONTACT OUR YORK OFFICE.

The following are the single plane loading stress and deflection limits upon which the loadings are based.

Maximum Stress (Tension)   : 17,600 psi
Maximum Stress (Compression):   *
Maximum Stress (Shear)   : 13,200 psi

Vertical and lateral deflection limited to 1/800 of the span. For computing lateral deflection a lateral load equal to 5% of the vertical load was used.

Vertical stress and deflection loading limits include the effect of the weight of the beam. Lateral stress and deflection loading limits do not include the effect of the weight of the beam. Therefore, the loadings shown in the charts should be used to assist in the selection of runway beams only and should not be used to as-sist in the selection of bridge beams.

Loadings shown in the charts are based ONLY upon SINGLE PLANE LOADING. Combined loads ARE NOT included. Consideration of combined loading or twisting of the beam about itself because of large lateral loads should be analyzed by structural/mechanical engineers or any similarly qualified personnel.

Lower flange loadings based on a maximum flange stress (tension) of 16,000 psi.

$$* \text{Compression: } \frac{12,000,000}{ld/A_f} \text{ with maximum of 17,600 psi}$$

Where = l = Span in inches
     d = Depth of beam in inches
 A_f = Area of compression flange in square inches

WARNING:

The material contained in this booklet is intended for use only by structural/mechanical engineers or any similarly qualified personnel. It will guide the user through a systematic sequence of simple computations to assist in determining loads; a tabulation of beams to support the load is then provided.

For unusual loading conditions not covered in this guide, contact our York office.

While every precaution was taken to insure that all data and information contained herein is accurate, *Acco* cannot assume responsibility for errors or oversights in its use.

RUNWAY BEAM SIZE SELECTION FOR FOUR WHEEL TOP RUNNING CRANE (TWO WHEELS PER END TRUCK)
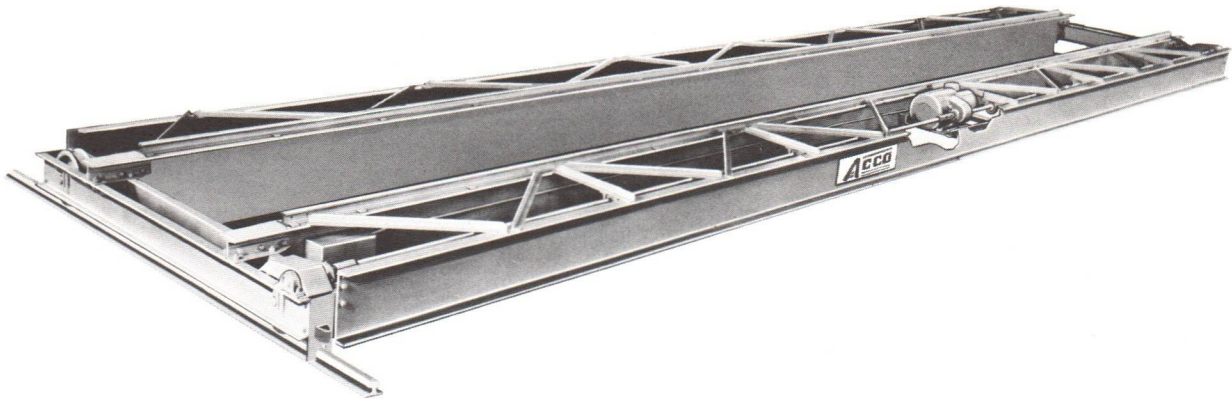
The purpose of this procedure is to outline the steps and calculations involved in selecting a runway beam for a 4-wheel top running crane having 2 wheels per end truck.

Top running cranes operate on rails attached to the runway beams on the center of the top flange directly above the beam web. Rail size must be selected according to Acco H & C Division catalog information to properly fit wheels supplied on the end truck or crane.

STEP 1—CALCULATE MAXIMUM WHEEL LOAD (M.W.L)

M.W.L. means the load on any wheel with the trolley and rated capacity load positioned on the bridge to give the maximum loading condition on that wheel. M.W.L. will occur when the trolley and rated capacity load are positioned at the extreme end of the bridge and on cranes without a cab or platform is calculated as follows:

$$\text{M.W.L.} = \frac{KP}{2} + \frac{H}{2} + \frac{C}{4}$$

Where: P = Weight of rated capacity load in pounds (1 ton = 2000 #)
H = Weight of hoist and trolley in pounds
C = Weight of crane in pounds
K = Impact allowance factor (not less than 1.15 or greater than 1.50)

Impact allowance of the rated capacity load shall be taken as one-half of one percent of the load per foot per minute of hoisting speed, but not less than 15% or more than 50%, except for bucket and magnet cranes for which the impact allowance shall be taken as 50% of the rated capacity load. Therefore:

$$K = 1 + (.005)(S)$$

where: S = Hoist hook speed in feet per minute

If a fixed bridge cab or platform is used, ½ of the weight of the cab or platform and mounted equipment shall be added to M.W.L.

STEP 2—CALCULATE EQUIVALENT CENTER LOAD (E.C.L.)

E.C.L. is the load that, when applied in a concentrated loading condition at the center of the runway span length between supports specified, causes a bending stress in the beam equivalent to the bending stress that occurs in the beam when a 2-wheel top running end truck of a specified wheel base operates on it. Refer to page 7 for procedure

to calculate E.C.L.

STEP 3—SELECT RUNWAY BEAM SIZE

Maximum center loads (M.C.L.) for various beams and composite beams are tabulated on pages 9 through 15. Any beam or composite beam having M.C.L. greater than E.C.L. for the span length under consideration may be used as the runway beam size.

EXAMPLE:

Select a runway beam for operation of a Series 544, 7½ ton crane with a 25 ft. span weighing 5935#. Crane has a 7½ ton top running trolley hoist weighing 2975# with a hook speed of 27 FPM. End truck wheel base is 7'-8" (7.67'). Runway span length between supports is 20'.

$$
\begin{aligned}
K &= 1 + (.005)(S) \\
&= 1 + (.005)(27) \\
&= 1 + .135 \\
&= 1.135 \quad \text{Use } 1.15
\end{aligned}
$$

$$
\begin{aligned}
\text{M.W.L.} &= \frac{KP}{2} + \frac{H}{2} + \frac{C}{4} \\
&= \frac{1.15(15000)}{2} + \frac{2975}{2} + \frac{5935}{4} \\
&= 8625 + 1488 + 1484 \\
&= 11597\#
\end{aligned}
$$

From page 7

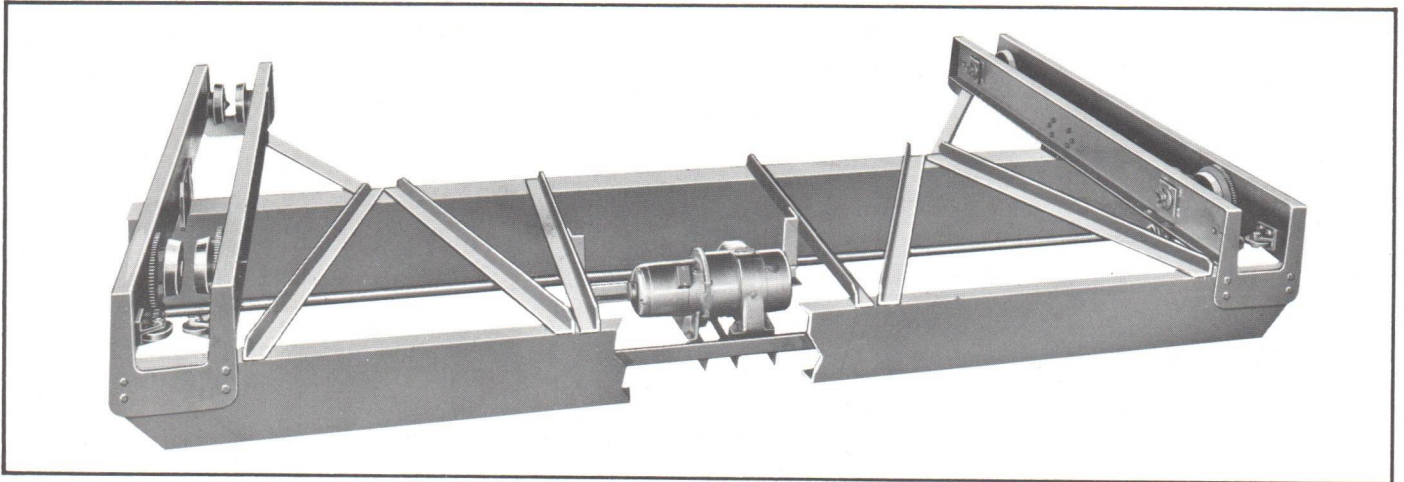$$\frac{A}{L} = \frac{7.67}{20} = .383 \quad \text{Use } .35$$

$$K_1 = 1.362$$

$$
\begin{aligned}
\text{E.C.L.} &= (K_1)(\text{M.W.L.}) \\
&= (1.362)(11597) \\
&= 15795\#
\end{aligned}
$$

Referring to M.C.L. tabulation for American Standard Shapes (I-beam) on page 7, a beam must be selected that has a M.C.L. greater than 15795# when the span length is 20'.

S20 × 66 has a M.C.L. of 17330# and, therefore, can be used.

The purpose of this procedure is to outline the steps and calculations involved in selecting a runway beam for an 8-wheel underhung crane having 4 wheels per end truck.

Underhung cranes operate on and are directly supported by the lower flanges of the runway beam. **Failure of the lower flange can occur at a significantly lower load than that which would cause failure of the beam, and therefore must be taken into consideration.**

STEP 1—CALCULATE MAXIMUM WHEEL PAIR LOAD (M.W.L.)

M.W.L. means the load on any pair of wheels with the trolley and rated capacity load positioned on the bridge to give the maximum loading condition on that pair of wheels. M.W.L. will occur when the trolley and rated capacity load are positioned at the extreme end of the bridge and on cranes without a cab or platform is calculated as follows:

$$\text{M.W.L.} = \frac{KP}{2} + \frac{H}{2} + \frac{C}{4}$$

Where: P = Weight of rated capacity load in pounds (1 ton = 2000#)
H = Weight of hoist and trolley in pounds
C = Weight of crane in pounds
K = Impact allowance factor (not less than 1.15 or greater than 1.50)

Impact allowance of the rated capacity load shall be taken as one-half of one percent of the load per foot per minute of hoisting speed, but not less than 15% or more than 50%, except for bucket and magnet cranes for which the impact allowance shall be taken as 50% of the rated capacity load. Therefore:

$$K = 1 + (.005)(S)$$

where: S = Hoist hook speed in feet per minute.

If a fixed bridge cab or platform is used, $\frac{1}{2}$ of the weight of the cab or platform and mounted equipment shall be added to M.W.L.

STEP 2—CALCULATE EQUIVALENT CENTER LOAD (E.C.L.)

E.C.L. is the load that, when applied in a concentrated loading condition at the center of the runway span length between supports specified, causes a bending stress in the beam equivalent to the bending stress that occurs in the beam when a 4-wheel underhung end truck of a specified wheel base operates on it. Refer to page 7 for procedure to calculate E.C.L.

STEP 3—SELECT RUNWAY BEAM SIZE

Maximum center loads (M.C.L.) for various beams and composite beams are tabulated on pages 9 through 15. Maximum lower flange loads (L.F.L.) per pair of wheels for various beams or basic beam of composite beams are tabulated on pages 9 through 11. Any beam or composite beam having M.C.L. greater than E.C.L. for the span length under consideration and having L.F.L. greater than M.W.L. may be used as the runway beam size.

EXAMPLE:

Select a runway beam for operation of a Series 524, 7½ ton crane with a 25 ft. span weighing 4190#. Crane has a 7½ ton hoist with a motorized trolley operating on it. Hoist hook speed is 27 FPM. Weight of hoist and motorized trolley is 1525#. End truck wheel base is 6'. Runway span length between supports is 20'.

$$
\begin{aligned}
K &= 1 + (.005)(S) \\
&= 1 + (.005)(27) \\
&= 1 + .135 \\
&= 1.135 \quad \text{Use } 1.15
\end{aligned}
$$

$$
\begin{aligned}
\text{M.W.L.} &= \frac{KP}{2} + \frac{H}{2} + \frac{C}{4} \\
&= \frac{1.15(15000)}{2} + \frac{1525}{2} + \frac{4190}{4} \\
&= 8625 + 763 + 1048 \\
&= 10436\#
\end{aligned}
$$

From page 7

$$\frac{A}{L} = \frac{6}{20} = .30$$

$$K_1 = 1.445$$

$$
\begin{aligned}
\text{E.C.L.} &= (K_1)(\text{M.W.L.}) \\
&= (1.445)(10436) \\
&= 15080\#
\end{aligned}
$$

Referring to M.C.L. tabulation for American Standard Shapes (I-beam) and L.F.L. tabulation on page 9, a beam must be selected that has a M.C.L. greater than 15080# when the span length is 20', and has a L.F.L. greater than 10436#.

S20 × 66 has a M.C.L. of 17330# and a L.F.L. of 11290# and, therefore, can be used.

RUNWAY BEAM EQUIVALENT CENTER LOAD AND MAXIMUM SUPPORT LOAD FOR TWO MOVING LOADS

The purpose of this procedure is to outline the steps and calculations involved in determining the equivalent center load and the maximum support load for runway beams subjected to two equal moving loads (2-wheel top running end truck or 4-wheel underhung end truck).
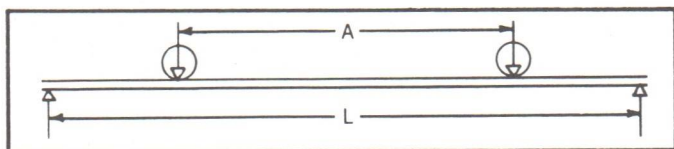
The figure above represents a runway beam span length between supports on which is operating two *equal* moving loads separated by a distance equal to a crane end truck wheel base. Each moving load is *equal* to M.W.L. and can be calculated by procedures outlined on information sheets for the product under investigation.

EQUIVALENT CENTER LOAD (E.C.L.)

E.C.L. is the load that, when applied in a concentrated loading condition at the center of the span length specified, causes a bending stress in the beam equivalent to the bending stress that occurs in the beam when two *equal* moving loads separated by a specified wheel base distance operates on it.

MAXIMUM SUPPORT LOAD (M.S.L.)

Loading at the runway span supports will vary as the two *equal* moving loads change position during operation on the runway. The maximum loading condition must be known for design of the support and is called M.S.L. caused by the moving crane loads.

The following information for calculating E.C.L. and M.S.L. is based on the standard A.I.S.C. equations for a simple beam having two *equal* concentrated moving loads.

STEP 1—CALCULATE RATIO A/L

Calculate the ratio A/L, where A = truck wheel base, and L = runway span length between supports. Values of A and L must be in the same units, both in inches, or both in feet.

STEP 2—SELECT MULTIPLICATION FACTORS

From the following table, select the multiplication factors K_1 and K_2 based on the calculated A/L ratio. When the calculated value of A/L falls between the A/L values shown in the table, use the next lower tabulated A/L value.

A/L	Less Than .05	.05	.10	.15	.20	.25	.30
K_1	2.000	1.902	1.805	1.712	1.620	1.532	1.445
K_2	2.000	1.950	1.900	1.850	1.800	1.750	1.700
A/L	.35	.40	.45	.50	.55	.60	.65
K_1	1.362	1.280	1.202	1.125	1.052	1.000	1.000
K_2	1.650	1.600	1.550	1.500	1.450	1.400	1.350
A/L	.70	.75	.80	.85	.90	.95	1.00 or greater
K_1	1.000	1.000	1.000	1.000	1.000	1.000	1.000
K_2	1.300	1.250	1.200	1.150	1.100	1.050	1.000

STEP 3—CALCULATE EQUIVALENT CENTER LOAD (E.C.L.)

E.C.L. is calculated by multiplying M.W.L. by multiplication factor K_1 or

$$E.C.L. = (K_1)(M.W.L.)$$

STEP 4—CALCULATE MAXIMUM SUPPORT LOAD (M.S.L.)

M.S.L. is calculated by multiplying M.W.L. by multiplication factor K_2 or

$$M.S.L. = (K_2)(M.W.L.)$$

The above calculated M.S.L. is based on loading caused by the crane only and the total load on the support to use in the support design must also include the runway beam weight, lateral and longitudinal loads caused by crane trolley and bridge movement, and weight of any attachments and equipment mounted on the runway.

EXAMPLE:

Find the E.C.L. and M.S.L. for a runway span of 30' on which an end truck having a 6'-9" wheel base operates. M.W.L. = 8000#

Wheel base = 6'-9" = 6.75'

$$\frac{A}{L} = \frac{6.75}{30} = .225$$

Table does not have an A/L value of .225, therefore, use the next lower value. A/L = .20

From table, under A/L value of .20,

$$K_1 = 1.620$$
$$K_2 = 1.800$$

$$E.C.L. = (K_1)(M.W.L.)$$
$$= (1.620)(8000)$$
$$= 12960\#$$

$$M.S.L. = (K_2)(M.W.L.)$$
$$= (1.800)(8000)$$
$$= 14400\#$$

SUPPLEMENTARY INFORMATION—TWO UNEQUAL MOVING LOADS

For conditions where two *unequal* moving loads are encountered, the E.C.L. and M.S.L. can be calculated by the standard A.I.S.C. equations for a simple beam having two *unequal* concentrated moving loads. Procedures and equations are as follows, where:

P_1 = Heavier load
P_2 = Lighter load
M = Maximum bending moment

Calculate M by the following two methods:

$$M = \frac{P_1 + P_2}{4L}\left(L - \frac{P_2 A}{P_1 + P_2}\right)^2$$

$$M = \frac{P_1 L}{4}$$

Use the largest value of M and calculate E.C.L. as follows:
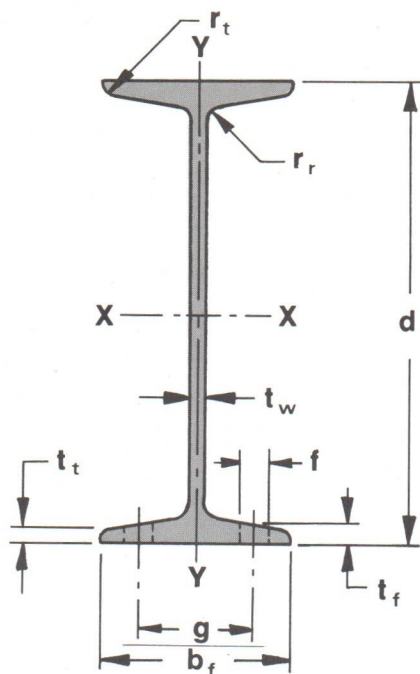
$$E.C.L. = \frac{4M}{L}$$

Calculate M.S.L. as follows:

Where A is less than L:

$$M.S.L. = P_1 + (P_2)\left(\frac{L - A}{L}\right)$$

Where A is equal to or greater than L:

$$M.S.L. = P_1$$

AMERICAN STANDARD SHAPES (S SHAPES)

Shape Designation Number	Depth of Section	Weight per Foot	Area of Section	Web Thickness	Flange Width	Flange Average Thickness	Area of Flange	$\frac{d}{A_f}$	Elastic Properties Axis X-X			Flange Nominal Thickness at Toe	Radius at Toe	Radius at Fillet	Usual Flange Gage	Maximum Flange Fastener
	d		A	t_w	b_f	t_f	A_f		I	S	r	t_t	r_t	r_r	g	f
	in.	lb.	in.^{2}	in.	in.	in.	in.^{2}		in.^{4}	in.^{3}	in.	in.	in.	in.	in.	in.
S6x12.5	6.0	12.5	3.67	0.232	3.332	0.359	1.196	5.02	22.1	7.37	2.45	¼	.14	.33	2	⅝
S6x17.25	6.0	17.25	5.07	0.465	3.565	0.359	1.280	4.69	26.3	8.77	2.28	¼	.14	.33	2	⅝
S7x15.3	7.0	15.3	4.50	0.252	3.662	0.392	1.435	4.88	36.7	10.5	2.86	¼	.15	.35	2¼	⅝
S8x18.4	8.0	18.4	5.41	0.271	4.001	0.425	1.700	4.70	57.6	14.4	3.26	¼	.16	.37	2¼	¾
S8x23	8.0	23.0	6.77	0.441	4.171	0.425	1.773	4.51	64.9	16.2	3.10	¼	.16	.37	2¼	¾
S10x25.4	10.0	25.4	7.46	0.311	4.661	0.491	2.288	4.37	124	24.7	4.07	5/16	.19	.41	2¾	¾
S10x35	10.0	35.0	10.3	0.594	4.944	0.491	2.428	4.12	147	29.4	3.78	5/16	.19	.41	2¾	¾
S12x31.8	12.0	31.8	9.35	0.350	5.000	0.544	2.720	4.41	218	36.4	4.83	⅜	.21	.45	3	¾
S12x35	12.0	35.0	10.3	0.428	5.078	0.544	2.762	4.34	229	38.2	4.72	⅜	.21	.45	3	¾
S12x40.8	12.0	40.8	12.0	0.462	5.252	0.659	3.461	3.46	272	45.4	4.77	7/16	.28	.56	3	¾
S12x50	12.0	50.0	14.7	0.687	5.477	0.659	3.609	3.32	305	50.8	4.55	7/16	.28	.56	3	¾
S15x42.9	15.0	42.9	12.6	0.411	5.501	0.622	3.422	4.38	447	59.6	5.95	7/16	.25	.51	3½	¾
S15x50	15.0	50.0	14.7	0.550	5.640	0.622	3.508	4.28	486	64.8	5.75	7/16	.25	.51	3½	¾
S18x54.7	18.0	54.7	16.1	0.461	6.001	0.691	4.147	4.34	804	89.4	7.07	7/16	.28	.56	3½	⅞
S18x70	18.0	70.0	20.6	0.711	6.251	0.691	4.319	4.17	926	103	6.71	7/16	.28	.56	3½	⅞
S20x66	20.0	66.0	19.4	0.505	6.255	0.795	4.972	4.02	1190	119	7.83	9/16	.30	.60	3½	⅞
S20x75	20.0	75.0	22.0	0.635	6.385	0.795	5.076	3.94	1280	128	7.62	9/16	.30	.60	3½	⅞
S20x86	20.3	86.0	25.3	0.660	7.060	0.920	6.495	3.13	1580	155	7.89	⅝	.36	.70	4	1
S20x96	20.3	96.0	28.2	0.800	7.200	0.920	6.624	3.06	1670	165	7.71	⅝	.36	.70	4	1
S24x80	24.0	80.0	23.5	0.500	7.000	0.870	6.090	3.94	2100	175	9.47	⅝	.30	.60	4	1
S24x90	24.0	90.0	26.5	0.625	7.125	0.870	6.199	3.87	2250	187	9.21	⅝	.30	.60	4	1
S24x100	24.0	100.0	29.3	0.745	7.245	0.870	6.303	3.81	2390	199	9.02	⅝	.30	.60	4	1
S24x106	24.5	106.0	31.2	0.620	7.870	1.090	8.578	2.86	2940	240	9.71	13/16	.30	.60	4	1
S24x121	24.5	121.0	35.6	0.800	8.050	1.090	8.774	2.79	3160	258	9.43	13/16	.30	.60	4	1

NOTE:

S20 and S24 shape information is based on new, revised profiles having an effective date of 1 September 1978, and is not applicable to the same size shapes rolled in accordance with previous obsolete profile standards. In addition to the shapes tabulated above, over thirty (30) sizes of American Standard shapes were rolled at one time and are now considered obsolete. These obsolete beams may still be found in older installations. For such cases, where the obsolete shape designation is known or actual measurements of the beam indicate it is not one of the above standard shapes, refer to the references, or contact the York Office.

REFERENCES:

"Manual of Steel Construction," Eighth (1980) Edition, American Institute of Steel Construction, New York.

"Steel Construction," Third (1937) Edition, American Institute of Steel Construction, New York.

"Bethlehem Structural Shapes," 1980 Edition, Catalog 3277B, Bethlehem Steel Corporation, Bethlehem, PA.

"Bethlehem Structural Shapes," 1975 Edition, Catalog 2747A, Bethlehem Steel Corporation, Bethlehem, PA.

"Bethlehem Structural Shapes," 1962 Edition, Catalog 1836, Bethlehem Steel Corporation, Bethlehem, PA.

AMERICAN STANDARD SHAPES (S SHAPES)
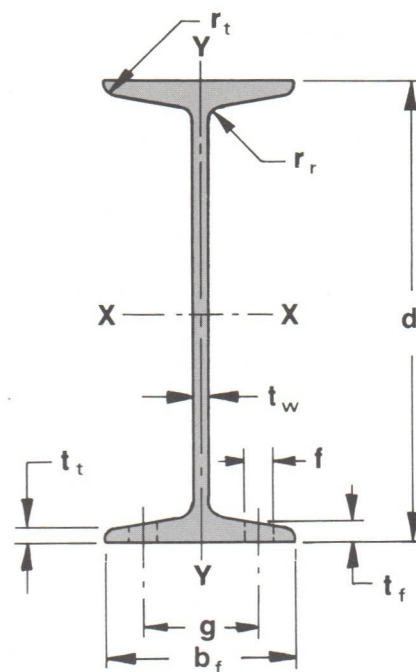
Lower flange loadings tabulated below are based on static load and do not consider service. Spacing between wheel centers must be equal to or greater than total flange width. All loading figures shown are in pounds.

| S Shape	Lower* Flange Loading	Span in feet																				
		10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
6x12.5	2,540	2687 D	1826 D	1301 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6x17.25	2,540	3183 D	2156 D	1528 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7x15.3	3,040	4496 D	3074 D	2209 D	1641 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8x18.4	3,600	7092 D	4867 D	3516 D	2631 D	2017 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8x23	3,600	7977 D	5467 D	3942 D	2942 D	2248 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10x25.4	4,830	14362 T	10584 D	7694 D	5807 D	4503 D	3561 D	2856 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10x35	4,830	17071 T	12510 D	9078 D	6835 D	5283 D	4161 D	3319 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12x31.8	5,810	21193 T	16266 L	11951 L	9150 L	7229 L	5856 L	4840 L	4067 L	3465 L	–	–	–	–	–	–	–	–	–	–	–	–
12x35	5,810	22233 T	17153 L	12602 L	9648 L	7623 L	6175 L	5103 L	4288 L	3654 L	–	–	–	–	–	–	–	–	–	–	–	–
12x40.8	7,870	26428 T	21948 T	17007 D	12886 D	10045 D	7998 D	6471 D	5296 D	4371 D	–	–	–	–	–	–	–	–	–	–	–	–
12x50	7,870	29549 T	24533 T	19033 D	14407 D	11216 D	8915 D	7197 D	5875 D	4833 D	–	–	–	–	–	–	–	–	–	–	–·	–
15x42.9	7,420	34747 T	25025 L	18386 L	14077 L	11122 L	9009 L	7445 L	6256 L	5331 L	4596 L	4004 L	3519 L	–	–	–	–	–	–	–	–	–
15x50	7,420	37762 T	27284 L	20046 L	15347 L	12126 L	9822 L	8118 L	6821 L	5812 L	5011 L	4365 L	3837 L	–	–	–	–	–	–	–	–	–
18x54.7	9,060	52052 L	36147 L	26557 L	20333 L	16065 L	13013 L	10755 L	9037 L	7700 L	6639 L	5784 L	5083 L	4503 L	4016 L	3605 L	–	–	–	–	–	–
18x70	9,060	60070 T	41882 L	30771 L	23559 L	18614 L	15078 L	12461 L	10471 L	8922 L	7693 L	6701 L	5890 L	5217 L	4654 L	4177 L	–	–	–	–	–	–
20x66	11,290	69319 L	48138 L	35367 L	27078 L	21395 L	17330 L	14322 L	12035 L	10254 L	8842 L	7702 L	6769 L	5996 L	5348 L	4800 L	4332 L	3929 L	–	–	–	–
20x75	11,290	74574 L	51788 L	38048 L	29131 L	23017 L	18644 L	15408 L	12947 L	11031 L	9512 L	8286 L	7282 L	6451 L	5754 L	5164 L	4661 L	4227 L	–	–	–	–
20x86	14,920	90493 T	75253 T	59754 L	45749 L	36147 L	29279 L	24198 L	20333 L	17325 L	14938 L	13013 L	11437 L	10131 L	9036 L	8110 L	7319 L	6639 L	–	–	–	–
20x96	14,920	96309 T	80081 T	64095 L	49072 L	38773 L	31406 L	25956 L	21810 L	18583 L	16023 L	13958 L	12268 L	10867 L	9693 L	8699 L	7851 L	7121 L	–	–	–	–
24x80	13,900	–	73337 L	53880 L	41252 L	32594 L	26401 L	21819 L	18334 L	15622 L	13470 L	11733 L	10313 L	9135 L	8148 L	7313 L	6600 L	5986 L	5454 L	4990 C	4504 C	3920 C
24x90	13,900	–	78029 L	57328 L	43892 L	34680 L	28091 L	23215 L	19507 L	16622 L	14332 L	12485 L	10973 L	9720 L	8670 L	7781 L	7023 L	6370 L	5804 L	5310 L	4828 C	4190 C
24x100	13,900	–	82895 L	60903 L	46629 L	36842 L	29842 L	24663 L	20724 L	17658 L	15225 L	13263 L	11657 L	10326 L	9210 L	8266 L	7460 L	6767 L	6166 L	5641 L	5161 C	4468 C
24x106	21,020	–	–	98440 L	75368 L	59550 L	48236 L	39864 L	33479 L	28542 L	24610 L	21438 L	18842 L	16690 L	14887 L	13362 L	12059 L	10938 L	9966 L	9118 L	8374 L	7717 L
24x121	21,020	–	–	–	81429 L	64339 L	52115 L	43070 L	36191 L	30837 L	26589 L	23162 L	20357 L	18032 L	16084 L	14436 L	13028 L	11817 L	10767 L	9851 L	9047 L	8338 L

Limits   T = Tension   C = Compression   D = Vertical Deflection   L = Lateral Deflection

*Recommended Lower Flange Loading per pair of wheels.
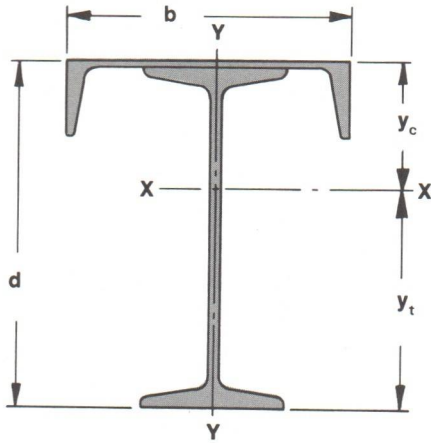
# AMERICAN STANDARD SHAPES (S SHAPES) WITH CAPPING CHANNEL

Theoretical Dimensions and Properties

S Shape	Channel	Total Weight per Foot lb.	Total Area in.²	Width b in.	Depth d in.	Yc in.	Yt in.	I in.⁴	Axis X-X Sc Upper in.³	Axis X-X St Lower in.³	Axis Y-Y I in.⁴	Axis Y-Y S in.³
8x18.4	7x9.8	28.2	8.28	7.0	8.210	2.938	5.272	83.81	28.53	15.90	25.03	7.15
8x18.4	8x11.5	29.9	8.79	8.0	8.220	2.817	5.403	86.62	30.75	16.03	36.33	9.08
8x23	7x9.8	32.8	9.64	7.0	8.210	3.118	5.092	93.00	29.83	18.26	25.61	7.32
8x23	8x11.5	34.5	10.15	8.0	8.220	3.005	5.215	96.24	32.02	18.45	36.91	9.23
10x25.4	8x11.5	36.9	10.84	8.0	10.220	3.770	6.450	175.6	46.58	27.22	39.39	9.85
10x25.4	9x13.4	38.8	11.40	9.0	10.233	3.632	6.601	181.1	49.86	27.43	54.69	12.15
10x25.4	10x15.3	40.7	11.95	10.0	10.240	3.509	6.731	185.7	52.93	27.60	74.19	14.84
10x35	8x11.5	46.5	13.68	8.0	10.220	4.071	6.149	203.3	49.94	33.07	40.96	10.24
10x35	9x13.4	48.4	14.24	9.0	10.233	3.951	6.282	209.9	53.13	33.41	56.26	12.50
10x35	10x15.3	50.3	14.79	10.0	10.240	3.842	6.398	215.6	56.12	33.70	75.76	15.15
12x31.8	8x11.5	43.3	12.73	8.0	12.220	4.720	7.500	298.5	63.25	39.80	41.96	10.49
12x31.8	9x13.4	45.2	13.29	9.0	12.233	4.563	7.670	307.7	67.43	40.11	57.26	12.72
12x31.8	10x15.3	47.1	13.84	10.0	12.240	4.421	7.819	315.6	71.39	40.36	76.76	15.35
12x40.8	8x11.5	52.3	15.38	8.0	12.220	4.979	7.241	357.5	71.80	49.37	46.2	11.55
12x40.8	9x13.4	54.2	15.94	9.0	12.233	4.841	7.392	367.8	75.98	49.76	61.5	13.67
12x40.8	10x15.3	56.1	16.49	10.0	12.240	4.714	7.526	378.3	80.25	50.26	81.0	16.20
15x42.9	8x11.5	54.4	15.98	8.0	15.220	6.208	9.012	584.5	94.16	64.86	47.0	11.75
15x42.9	9x13.4	56.3	16.54	9.0	15.233	6.034	9.199	601.4	99.67	65.38	62.3	13.84
15x42.9	10x15.3	58.2	17.09	10.0	15.240	5.873	9.367	616.4	104.9	65.81	81.8	16.36
15x42.9	12x20.7	63.6	18.69	12.0	15.282	5.474	9.808	656.9	120.0	66.98	143.4	23.90
15x50	8x11.5	61.5	18.08	8.0	15.220	6.384	8.836	627.8	98.33	71.05	48.3	12.08
15x50	9x13.4	63.4	18.64	9.0	15.233	6.225	9.008	645.8	103.7	71.69	63.6	14.13
15x50	10x15.3	65.3	19.19	10.0	15.240	6.077	9.163	662.0	108.9	72.24	83.1	16.62
15x50	12x20.7	70.7	20.79	12.0	15.282	5.707	9.575	706.0	123.7	73.73	144.7	24.12
18x54.7	8x11.5	66.2	19.48	8.0	18.220	7.719	10.501	1014	131.4	96.59	53.4	13.35
18x54.7	9x13.4	68.1	20.04	9.0	18.233	7.536	10.697	1042	138.2	97.37	68.7	15.27
18x54.7	10x15.3	70.0	20.59	10.0	18.240	7.363	10.877	1066	144.8	98.03	88.2	17.64
18x54.7	12x20.7	75.4	22.19	12.0	18.282	6.926	11.356	1133	163.6	99.81	149.8	24.97
18x70	9x13.4	83.4	24.54	9.0	18.233	7.847	10.386	1174	149.6	113.1	72.0	16.00
18x70	10x15.3	85.3	25.09	10.0	18.240	7.700	10.540	1201	156.0	114.0	91.5	18.30
18x70	12x20.7	90.7	26.69	12.0	18.282	7.324	10.958	1276	174.2	116.5	153.1	25.52
20x66	10x15.3	81.3	23.89	10.0	20.240	8.435	11.805	1529	181.2	129.5	95.1	19.02
20x66	12x20.7	86.7	25.49	12.0	20.282	7.992	12.290	1620	202.6	131.8	156.7	26.12
20x66	15x33.9	99.9	29.36	15.0	20.400	7.139	13.261	1806	253.0	136.2	342.7	45.69
20x86	10x15.3	101.3	29.79	10.0	20.540	8.920	11.620	1945	218.1	167.4	114.2	22.84
20x86	12x20.7	106.7	31.39	12.0	20.582	8.544	12.038	2049	239.8	170.2	175.8	29.30
20x86	15x33.9	119.9	35.26	15.0	20.700	7.792	12.908	2269	291.2	175.8	361.8	48.24
24x80	10x15.3	95.3	27.99	10.0	24.240	10.378	13.862	2610	251.5	188.3	109.6	21.92
24x80	12x20.7	100.7	29.59	12.0	24.282	9.898	14.384	2753	278.1	191.4	171.2	28.53
24x80	15x33.9	113.9	33.46	15.0	24.400	8.943	15.457	3051	341.2	197.4	357.2	47.62
24x106	10x15.3	121.3	35.69	10.0	24.740	10.998	13.742	3494	317.7	254.3	144.5	28.90
24x106	12x20.7	126.7	37.29	12.0	24.782	10.599	14.183	3657	345.1	257.9	206.1	34.35
24x106	15x33.9	139.9	41.16	15.0	24.900	9.779	15.121	4011	410.1	265.2	392.1	52.28
24x121	10x15.3	136.3	40.09	10.0	24.740	11.162	13.578	3723	333.5	274.2	150.7	30.14
24x121	12x20.7	141.7	41.69	12.0	24.782	10.803	13.979	3892	360.3	278.4	212.3	35.38
24x121	15x33.9	154.9	45.56	15.0	24.900	10.057	14.843	4263	423.9	287.2	398.3	53.11

NOTES AND REFERENCES: Refer to page 5.

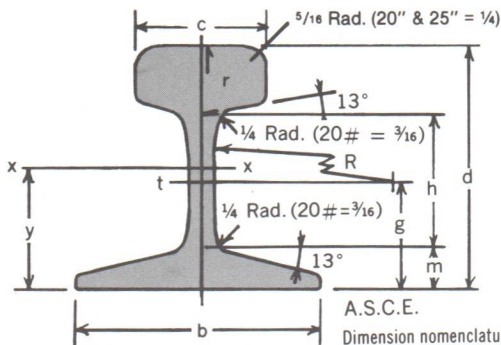# AMERICAN STANDARD SHAPES (S SHAPES) WITH CAPPING CHANNEL
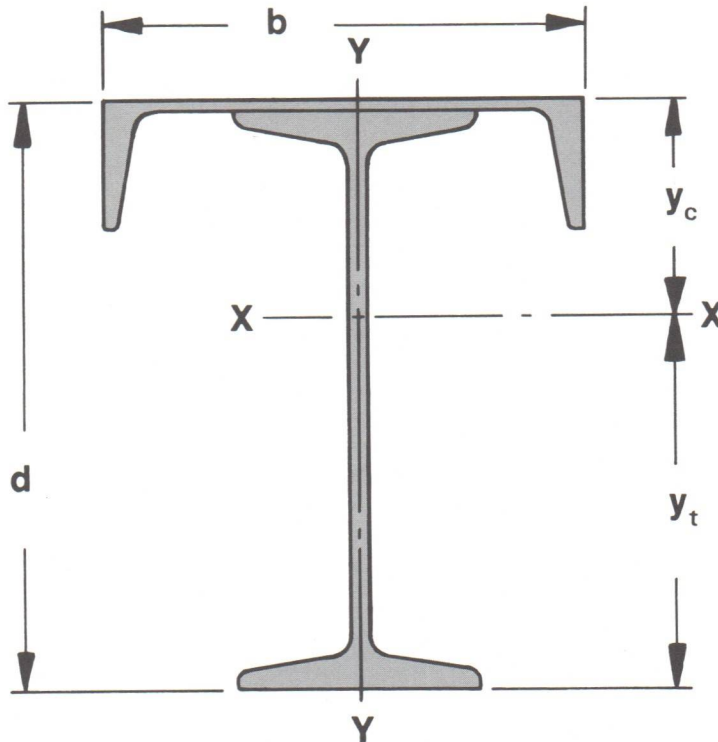
Beam Loading

S Shape	Channel	Span in feet				
		10	12	14	16	
8x18.4	7x9.8	9186 T	7071 D	5103 D	3814 D	
8x18.4	8x11.5	9254 T	7302 D	5268 D	3934 D	
8x23	7x9.8	10547 T	7835 D	5650 D	4217 D	
8x23	8x11.5	10650 T	8103 D	5842 D	4359 D	
10x25.4	8x11.5	15783 T	13085 D	10886 D	8213 D	
10x25.4	9x13.4	15896 T	13176 T	11220 T D	8462 D	
10x25.4	10x15.3	15987 T	13248 T	11279 T	8671 D	
10x35	8x11.5	19166 T	15887 D	12572 D	9472 D	
10x35	9x13.4	19356 T	16041 T	12976 D	9775 D	
10x35	10x15.3	19517 T	16172 D	13324 D	10035 D	
12x31.8	8x11.5	23130 T	19196 T	16373 T	14158 D	
12x31.8	9x13.4	23302 T	19336 T	16490 T	14344 T	
12x31.8	10x15.3	23440 T	19447 T	16581 T	14420 T	
12x40.8	8x11.5	28699 T	23820 T	20320 T	16949 D	
12x40.8	9x13.4	28918 T	23999 T	20470 T	17436 D	
12x40.8	10x15.3	29202 T	24232 T	20666 T	17928 D	
15x42.9	8x11.5	37775 T	31379 T	·26795 T	23344 T	
15x42.9	9x13.4	38070 T	31622 T	27000 T	23519 T	
15x42.9	10x15.3	38313 T	31821 T	27167 T	23662 T	
15x42.9	12x20.7	38972 T	32360 T	27619 T	24048 T	
15x50	8x11.5	41370 T	34362 T	29339 T	25557 T	
15x50	9x13.4	41736 T	34664 T	29594 T	25776 T	
15x50	10x15.3	42049 T	34921 T	29811 T	25962 T	
15x50	12x20.7	42896 T	35617 T	30398 T	26466 T	
18x54.7	8x11.5	56328 T	46819 T	40008 T	34883 T	
18x54.7	9x13.4	56777 T	47189 T	40321 T	35153 T	
18x54.7	10x15.3	57154 T	47500 T	40584 T	35380 T	
18x54.7	12x20.7	58171 T	48338 T	41292 T	35989 T	
18x70	9x13.4	65904 T	54767 T	46788 T	40783 T	
18x70	10x15.3	66434 T	55205 T	47160 T	41105 T	
18x70	12x20.7	67862 T	56385 T	48162 T	41971 T	
20x66	10x15.3	75558 T	62816 T	53691 T	46827 T	
20x66	12x20.7	76868 T	63898 T	54609 T	47620 T	
20x66	15x33.9	79401 T	65984 T	56372 T	49139 T	
20x86	10x15.3	97690 T	81223 T	69431 T	60562 T	
20x86	12x20.7	99311 T	82564 T	70571 T	61549 T	
20x86	15x33.9	–	85222 T	72825 T	63497 T	
24x80	10x15.3	–	91470 T	78226 T	68269 T	
24x80	12x20.7	–	92948 T	79483 T	69359 T	
24x80	15x33.9	–	95822 T	81921 T	71468 T	
24x106	10x15.3	–	–	–	92248 T	
24x106	12x20.7	–	–	–	93531 T	
24x106	15x33.9	–	–	–	96124 T	
24x121	10x15.3	–	–	–	–	
24x121	12x20.7	–	–	–	–	
24x121	15x33.9	–	–	–	–	

All loading figures shown are in pounds.

	Span in Feet																
	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
	2919 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	3008 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	3222 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	3328 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6366 D	5031 D	4032 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6556 D	5179 D	4147 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6715 D	5301 D	4242 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	7328 D	5779 D	4617 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	7561 D	5961 D	4761 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	7761 D	6116 D	4882 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	11042 D	8797 D	7122 D	5835 D	4822 D	–	–	–	–	–	–	–	–	–	–	–	–
	11373 D	9059 D	7332 D	6005 D	4960 D	–	–	–	–	–	–	–	–	–	–	–	–
	11658 D	9283 D	7511 D	6149 D	5076 D	–	–	–	–	–	–	–	–	–	–	–	–
	13216 D	10528 D	8522 D	6981 D	5766 D	–	–	–	–	–	–	–	–	–	–	–	–
	13595 D	10828 D	8764 D	7177 D	5927 D	–	–	–	–	–	–	–	–	–	–	–	–
	13978 D	11132 D	9008 D	7376 D	6090 D	–	–	–	–	–	–	–	–	–	–	–	–
	20647 T	17604 D	14363 D	11881 D	9935 D	8376 D	7106 D	6054 D	–	–	–	–	–	–	–	–	–
	20800 T	18109 D	14773 D	12220 D	10217 D	8613 D	7305 D	6222 D	–	–	–	–	–	–	–	–	–
	20923 D	18555 D	15135 D	12517 D	10464 D	8819 D	7478 D	6368 D	–	–	–	–	–	–	–	–	–
	21255 D	19009 D	16107 D	13315 D	11125 D	9371 D	7940 D	6754 D	–	–	–	–	–	–	–	–	–
	22601 T	18868 D	15383 D	12714 D	10620 D	8942 D	7574 D	6440 D	–	–	–	–	–	–	–	–	–
	22792 D	19408 D	15823 D	13077 D	10923 D	9197 D	7789 D	6623 D	–	–	–	–	–	–	–	–	–
	22954 D	19890 D	16214 D	13400 D	11191 D	9421 D	7978 D	6782 D	–	–	–	–	–	–	–	–	–
	23391 T	20918 T	17278 D	14275 D	11918 D	10029 D	8489 D	7212 D	–	–	–	–	–	–	–	–	–
	30882 T	27668 T	25026 T	21039 D	17697 D	15028 D	12859 D	11069 D	9571 D	8303 D	7216 D	–	–	–	–	–	–
	31119 T	27877 T	25213 T	21605 D	18172 D	15431 D	13204 D	11365 D	9827 D	8524 D	7408 D	–	–	–	–	–	–
	31317 T	28052 T	25368 T	22112 D	18598 D	15792 D	13511 D	11629 D	10053 D	8719 D	7577 D	–	–	–	–	–	–
	31848 T	28520 T	25783 T	23490 TD	19754 D	16770 D	14344 D	12341 D	10666 D	9246 D	8030 D	–	–	–	–	–	–
	36094 T	32326 T	29208 T	24255 D	20378 D	17280 D	14760 D	12679 D	10936 D	9459 D	8193 D	–	–	–	–	–	–
	36377 T	32577 T	29452 T	24815 D	20849 D	17679 D	15101 D	12972 D	11190 D	9678 D	8383 D	–	–	–	–	–	–
	37136 T	33250 T	30055 T	26362 D	22147 D	18780 D	16042 D	13780 D	11886 D	10280 D	8904 D	–	–	–	–	–	–
	41471 T	37169 T	33635 T	30676 D	26974 D	22974 D	19728 D	17053 D	14818 D	12929 D	11315 D	9922 D	8709 D	–	–	–	–
	42165 T	37784 T	34183 T	31169 D	28568 D	24330 D	20890 D	18055 D	15687 D	13685 D	11974 D	10498 D	9212 D	–	–	–	–
	43490 T	38951 T	35219 T	32093 D	29432 D	27079 D	23238 D	20072 D	17427 D	15191 D	13278 D	11628 D	10189 D	–	–	–	–
	53642 T	48085 T	43520 T	39700 T	34357 D	29271 D	25143 D	21742 D	18901 D	16500 D	14449 D	12679 D	11138 D	–	–	–	–
	54509 T	48855 T	44210 T	40322 T	36190 D	30832 D	26484 D	22901 D	19909 D	17380 D	15219 D	13355 D	11732 D	–	–	–	–
	56215 T	50366 T	45558 T	41532 D	38106 D	34118 D	29300 D	25330 D	22014 D	19211 D	16815 D	14748 D	12949 D	–	–	–	–
	60504 T	54272 T	49156 T	44877 T	40573 L	34984 L	30475 L	26784 L	23726 L	21163 L	18994 L	17142 L	15548 L	14167 L	12693 D	11315 D	10084 D
	61462 T	55125 T	49921 T	45568 T	41869 T	38684 L	35910 T	31623 D	27656 D	24311 D	21462 D	19010 D	16883 D	15022 D	13383 D	11929 D	10631 D
	63312 T	56764 T	51386 T	46886 T	43060 T	39765 T	36893 T	34367 D	30608 D	26897 D	23735 D	21015 D	18654 D	16589 D	14769 D	13154 D	11713 D
	81769 T	73361 T	66460 T	60690 T	53493 D	46124 D	40179 D	35313 D	31281 D	27902 D	25042 L	22600 L	20499 L	18678 L	17089 L	15335 D	13696 D
	82900 T	74369 T	67366 T	61510 T	56534 T	52252 T	48471 D	42155 D	36894 D	32459 D	28682 D	25434 D	22616 D	20153 D	17984 D	16061 D	14345 D
	85179 T	76396 T	69183 T	63150 T	58023 T	53609 T	49765 T	46207 D	40436 D	35572 D	31428 D	27865 D	24775 D	22072 D	19693 D	17583 D	15700 D
	88122 T	79051 T	71604 T	65376 T	55788 L	48103 L	41903 L	36829 L	32623 L	29099 L	26117 L	23570 L	21379 L	19479 L	17822 L	16127 L	14372 L
	89462 T	80246 T	72681 T	66352 T	60976 T	56347 T	51453 D	44723 D	39116 D	34388 D	30359 D	26894 D	23887 D	21257 D	18940 D	16885 D	15051 D
	92211 T	82695 T	74882 T	68345 T	62790 T	58006 T	53839 T	48995 D	42853 D	37675 D	33262 D	29467 D	26174 D	23293 D	20756 D	18505 D	16496 D

Limits T = Tension C = Compression D = Vertical Defl. L = Lateral Defl.

A.S.C.E. — 5/16 Rad. (20″ & 25″ = 1/4); c; r; 13°; 1/4 Rad. (20# = 3/16); x—x; R; t; 1/4 Rad. (20#=3/16); 13°; d; h; g; m; y; b

BETHLEHEM 104 LB. — 5/16 Rad.; 13°; 1/2 Rad.; 1/2 Rad.; 13°; h; m

U.S. STEEL 105 LB. — 5/16 Rad.; 13°; 1/4 Rad.; 1/4 Rad.; 13°; h; m

Dimension nomenclature on sketch of A.S.C.E. rail also applies to the other rails.
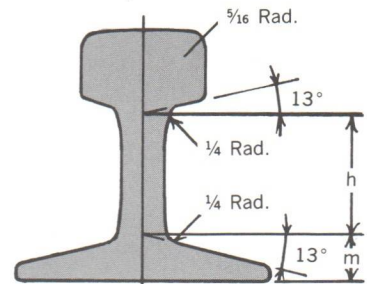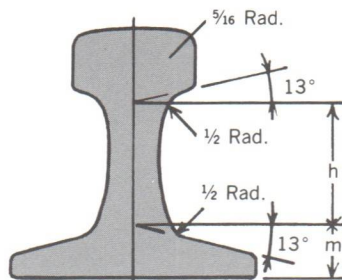
Type	Desig. (wt. per Yard)	Depth of Section	Base Width	Head Width	Head Radius	Base Thickness	Web Depth	Web Thickness	L Web Radius (Gage)	Web Radius	Area of Section	Base to Neutral Axis	Elastic Properties Axis X-X		
		d	b	c	r	m	h	t	g	R	A	y	I	S-head	S-base
	lb.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.^{2}	in.	in.^{4}	in.^{3}	in.^{3}
A.S.C.E.	20	2 5/8	2 5/8	1 11/32	12	7/16	1 15/32	1/4	1 11/64	12	2.00	1.26	1.93	1.41	1.53
A.S.C.E.	25	2 3/4	2 3/4	1 1/2	12	31/64	1 31/64	19/64	1 15/64	12	2.40	1.33	2.50	1.76	1.88
A.S.C.E.	30	3 1/8	3 1/8	1 11/16	12	17/32	1 23/32	21/64	1 25/64	12	3.00	1.52	4.10	2.55	2.69
A.S.C.E.	40	3 1/2	3 1/2	1 7/8	12	5/8	1 55/64	25/64	1 9/16	12	3.94	1.68	6.54	3.59	3.89
A.S.C.E.	60	4 1/4	4 1/4	2 3/8	12	49/64	2 17/64	31/64	1 29/32	12	5.93	2.05	14.60	6.64	7.12
A.S.C.E.	70	4 5/8	4 5/8	2 7/16	12	13/16	2 15/32	33/64	2 3/64	12	6.81	2.22	19.70	8.19	8.87
A.S.C.E.	75	4 13/16	4 13/16	2 15/32	12	27/32	2 35/64	17/32	2 1/8	12	7.33	2.30	22.86	9.10	9.94
A.S.C.E.	80	5	5	2 1/2	12	7/8	2 5/8	35/64	2 3/16	12	7.86	2.38	26.38	10.07	11.08
A.S.C.E.	85	5 3/16	5 3/16	2 9/16	12	57/64	2 3/4	9/16	2 17/64	12	8.33	2.47	30.07	11.08	12.17
A.S.C.E.	90	5 3/8	5 3/8	2 5/8	12	59/64	2 55/64	9/16	2 23/64	12	8.83	2.55	34.39	12.19	13.49
A.S.C.E.	100	5 3/4	5 3/4	2 3/4	12	31/32	3 5/64	9/16	2 1/2	12	9.84	2.73	43.97	14.55	16.11
Crane *1	104	5	5	2 1/2	12	1 1/16	2 7/16	1	2 7/16	3 1/2	10.3	2.21	29.8	10.7	13.5
Crane *2	105	5 3/16	5 3/16	2 9/16	12	1	2 13/32	15/16	2 13/64	12	10.3	2.41	34.4	12.4	14.3
Crane *3	135	5 3/4	5 3/16	3 7/16	14	1 1/16	2 13/16	1 1/4	2 15/32	12	13.3	2.81	50.6	17.2	18.0
Crane *1	171	6	6	4.3	Flat	1 1/4	2 3/4	1 1/4	2 5/8	Vert.	16.8	3.01	73.4	24.5	24.4
Crane *3	175	6	6	4 1/4	18	1 9/64	3 7/64	1 1/2	2 21/32	Vert.	17.1	3.02	70.2	23.5	23.3

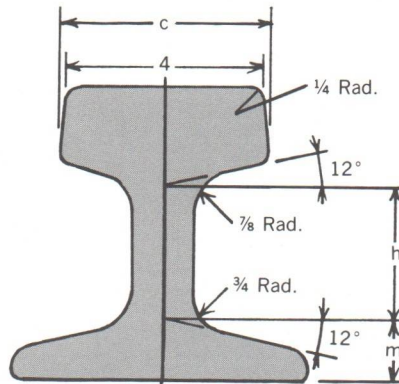*1 Bethlehem   *2 U.S. Steel   *3 Bethlehem & U.S. Steel.

REFERENCES:
- "Manual of Steel Construction," Eighth (1980) Edition, American Institute of Steel Construction, Inc., New York.
- "Bethlehem Trackwork," Bethlehem Steel Corporation, Bethlehem, Pa., Catalog 2341.
- "C.M.A.A." Specification No. 70, Revised 1975. Crane Manufacturers Association of American, Inc., Pittsburgh, Pa., 1975.
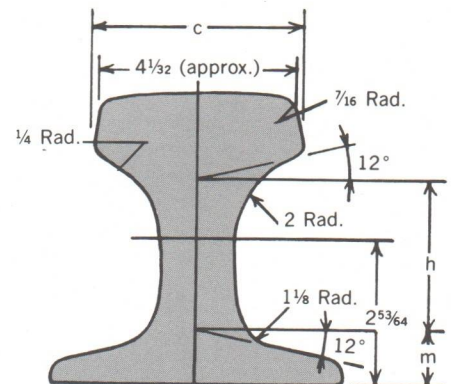
CRANE RAILS
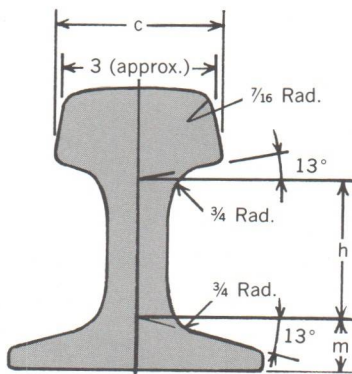
U.S. STEEL &
BETHLEHEM 135 LB.

BETHLEHEM 171 LB.

U.S. STEEL &
BETHLEHEM 175 LB.

GUIDE FOR MAXIMUM BRIDGE AND TROLLEY WHEEL LOADINGS, LBS. (P)

C.M.A.A. Service Class	Wheel Dia. (D) Inches	ASCE 20#	ASCE 25#	ASCE 30#	ASCE 40#	ASCE 60 & 70#	ASCE 80 & 85# Beth. 104# USS 105#	ASCE 100#	BETH. & USS 135#	BETH. & USS 175#	Bethlehem 171#
Class A1 & A2 INFREQUENT SERVICE	8	10800	12800	13610	16000						
	9	12150	14400	15310	18000	25200					
	10	13500	16000	17010	20000	28000					
Class B LIGHT SERVICE	12		19200	20410	24000	33600	36000	40800			
	15			25510	30000	42000	45000	51000			
	18			30610	36000	50400	54000	61200			
Class C MODERATE SERVICE	21				42000	58800	63000	71400	75600	105000	117600
	24					67200	72000	81600	86400	120000	134400
P = 1600 WD											
Class D HEAVY DUTY SERVICE	8	9450	11200	11900	14000						
	9	10630	12600	13390	15750	22050					
	10	11820	14000	14880	17500	24500					
	12		16800	17860	21000	29400	31500	35700			
	15			22320	26250	36750	39380	44630			
	18			26790	31500	44100	47250	53550			
P = 1400 WD	21				36750	51450	55130	62480	66150	91880	102900
	24					58800	63000	71400	75600	105000	117600
Class E SEVERE DUTY-CYCLE SERVICE	8	8100	9600	10200	12000						
	9	9120	10800	11480	13500	18900					
	10	10130	12000	12760	15000	21000					
	12		14400	15310	18000	25200	27000	30600			
	15			19130	22500	31500	33750	38250			
	18			22960	27000	37800	40500	45900			
P = 1200 WD	21				31500	44100	47250	53550	56700	78750	88200
	24					50400	54000	61200	64800	90000	100800
Effective Width of Rail Head (W) Inches (Top of head minus corner radii)		.844	1.000	1.063	1.250	1.750	1.875	2.125	2.250	3.125	3.500

NOTE: The loading limits for Class E are also recommended wherever travel speeds exceed 400 f.p.m.

NOTES: Figures based on acceptable cast chilled iron, or rolled, forged, or cast steel properly heat treated. Figures do not include any allowance for impact. For unusual conditions, consideration must be given to other factors that are not included in the simple formula on which the table figures are based.

WIDE FLANGE SHAPES (W SHAPES)
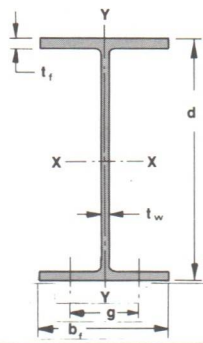
Shape Designation Number	Depth of Section d in.	Weight per Foot lb.	Area of Section A in.²	Web Thickness t_w in.	Flange Width b_f in.	Flange Thickness t_f in.	Area of Flange A_f in.²	$\frac{d}{A_f}$	Elastic Properties Axis X-X I in.⁴	S in.³	r in.	Usual Flange Gage g in.
W6x9	5.90	9.0	2.68	0.170	3.940	0.215	0.847	6.96	16.4	5.56	2.47	2¼
W6x15	5.99	15.0	4.43	0.230	5.990	0.260	1.557	3.85	29.1	9.72	2.56	3½
W8x10	7.89	10.0	2.96	0.170	3.940	0.205	0.808	9.77	30.8	7.81	3.22	2¼
W8x18	8.14	18.0	5.26	0.230	5.250	0.330	1.732	4.70	61.9	15.2	3.43	2¾
W8x24	7.93	24.0	7.08	0.245	6.495	0.400	2.598	3.05	82.8	20.9	3.42	3½
W8x31	8.00	31.0	9.13	0.285	7.995	0.435	3.478	2.30	110	27.5	3.47	5½
W10x12	9.87	12.0	3.54	0.190	3.960	0.210	0.832	11.86	53.8	10.9	3.90	2¼
W10x22	10.17	22.0	6.49	0.240	5.750	0.360	2.070	4.91	118.0	23.2	4.27	2¾
W10x33	9.73	33.0	9.71	0.290	7.960	0.435	3.463	2.81	170.0	35.0	4.19	5½
W10x49	9.98	49.0	14.4	0.340	10.000	0.560	5.600	1.78	272.0	54.6	4.35	5½
W12x14	11.91	14.0	4.16	0.200	3.970	0.225	0.893	13.33	88.6	14.9	4.62	2¼
W12x26	12.22	26.0	7.65	0.230	6.490	0.380	2.466	4.96	204	33.4	5.17	3½
W12x40	11.94	40.0	11.8	0.295	8.005	0.515	4.123	2.90	310	51.9	5.13	5½
W12x53	12.06	53.0	15.6	0.345	9.995	0.575	5.747	2.10	425.0	70.6	5.23	5½
W12x65	12.12	65.0	19.1	0.390	12.000	0.605	7.260	1.67	533	87.9	5.28	5½
W14x22	13.74	22.0	6.49	0.230	5.000	0.335	1.675	8.20	199	29.0	5.54	2¾
W14x30	13.84	30.0	8.85	0.270	6.730	0.385	2.591	5.34	291	42.0	5.73	3½
W14x43	13.66	43.0	12.6	0.305	7.995	0.530	4.237	3.22	428	62.7	5.82	5½
W14x61	13.89	61.0	17.9	0.375	9.995	0.645	6.447	2.15	640	92.2	5.98	5½
W14x82	14.31	82.0	24.1	0.510	10.130	0.855	8.661	1.65	882	123.0	6.05	5½
W14x90	14.02	90.0	26.5	0.440	14.520	0.710	10.309	1.36	999	143.0	6.14	5½
W16x26	15.69	26.0	7.68	0.250	5.500	0.345	1.897	8.27	301	38.4	6.26	2¾
W16x36	15.86	36.0	10.6	0.295	6.985	0.430	3.004	5.28	448	56.5	6.51	3½
W16x57	16.43	57.0	16.8	0.430	7.120	0.715	5.084	3.23	758	92.2	6.72	3½
W16x89	16.75	89.0	26.2	0.525	10.365	0.875	9.069	1.85	1300	155.0	7.05	5½
W18x35	17.70	35.0	10.3	0.300	6.000	0.425	2.550	6.94	510	57.6	7.04	3½
W18x46	18.06	46.0	13.5	0.360	6.060	0.605	3.666	4.93	712	78.8	7.25	3½
W18x65	18.35	65.0	19.1	0.450	7.590	0.750	5.692	3.22	1070	117.0	7.49	3½
W18x97	18.59	97.0	28.5	0.535	11.145	0.870	9.696	1.92	1750	188.0	7.82	5½
W21x44	20.66	44.0	13.0	0.350	6.500	0.450	2.925	7.06	843	81.6	8.06	3½
W21x57	21.06	57.0	16.7	0.405	6.555	0.650	4.261	4.94	1170	111	8.36	3½
W21x83	21.43	83.0	24.3	0.515	8.355	0.835	6.976	3.07	1830	171	8.67	5½
W21x111	21.51	111.0	32.7	0.550	12.340	0.875	10.798	1.99	2670	249	9.05	5½
W24x55	23.57	55.0	16.2	0.395	7.005	0.505	3.538	6.66	1350	114	9.11	3½
W24x68	23.73	68.0	20.1	0.415	8.965	0.585	5.245	4.52	1830	154	9.55	5½
W24x76	23.92	76.0	22.4	0.440	8.990	0.680	6.113	3.91	2100	176	9.69	5½
W24x104	24.06	104.0	30.6	0.500	12.750	0.750	9.562	2.52	3100	258	10.1	5½
W27x84	26.71	84.0	24.8	0.460	9.960	0.640	6.374	4.19	2850	213	10.7	5½
W27x94	26.92	94.0	27.7	0.490	9.990	0.745	7.443	3.62	3270	243	10.9	5½
W30x99	29.65	99.0	29.1	0.520	10.450	0.670	7.002	4.23	3990	269	11.7	5½
W30x108	29.83	108.0	31.7	0.545	10.475	0.760	7.961	3.75	4470	299	11.9	5½
W33x118	32.86	118.0	34.7	0.550	11.480	0.740	8.495	3.87	5900	359	13.0	5½
W36x135	35.55	135.0	39.7	0.600	11.950	0.790	9.440	3.77	7800	439	14.0	5½
W36x150	35.85	150.0	44.2	0.625	11.975	0.940	11.256	3.18	9040	504	14.3	5½
W36x230	35.90	230.0	67.6	0.760	16.470	1.260	20.752	1.73	15000	837	14.9	5½

NOTE: Wide Flange shape information is based on new, revised profiles having an effective date of 1 September 1978, and is not applicable to the same size shape rolled in accordance with previous obsolete profile standards. Approximately 135 sizes of Wide Flange shapes are currently produced in addition to those listed above. For information on these unlisted sizes, refer to the references, or contact the York office.

Wide Flange shape profiles rolled prior to 1 September 1978 are now considered obsolete. These obsolete beams may still be found in existing installations. For such cases, where the obsolete shape designation is known or actual measurements of the beam indicate it is not one of the present standard shapes, refer to the references or contact the York office.

"Comparison Catalog Structural Shapes, New Profiles W, HP, and WT Shapes," 1977 Edition, Catalog 3223, Bethlehem Steel Corporation, Bethlehem, PA.

"Interim Catalog Structural Shapes, New Profiles W, HP, and WT Shapes," 1977 Edition, Catalog 3231, Bethlehem Steel Corporation, Bethlehem, PA.

"New Series W, WT, HP Structural Steel Shapes," 1977 Edition, United States Steel Corporation, Pittsburgh, PA.

REFERENCES: See page 5.

W Shape	Lower* Flange Loading	Span in feet 10	12	
6x9	490	1996 D	1357 D	
6x15	720	3547 D	2416 D	●
8x10	450	2616 C	1791 C	
8x18	1,160	7632 D	5243 D	
8x24	1,705	10210 D	7014 D	
8x31	2,020	13570 D	9325 D	
10x12	470	3003 C	2055 C	
10x22	1,380	13499 T	10088 T	
10x33	2,020	20366 T	14524 D	
10x49	3,345	31783 T	23266 D	
12x14	540	3654 T	2502 T	
12x26	1,540	19462 T	15446 C	
12x40	2,830	30244 T	25130 T	
12x53	3,525	41149 T	34194 T	
12x65	3,905	51237 T	42578 T	
14x22	1,200	11674 C	8052 C	
14x30	1,580	24487 T	18021 C	
14x43	2,995	36565 T	30392 T	
14x61	4,440	53779 T	44704 T	
14x82	7,800	71742 T	59635 T	
14x90	5,375	83434 T	69363 T	
16x26	1,270	15345 C	10590 C	●
16x36	1,970	32963 T	24556 T	
16x57	5,450	53800 T	44728 T	
16x89	8,165	90478 T	75235 T	
18x35	1,925	27486 C	18999 C	
18x46	3,905	45994 T	36751 C	
18x65	6,000	68307 T	56804 T	
18x97	8,070	–	91319 T	
21x44	2,160	38289 C	26478 C	
21x57	4,505	64828 T	51645 C	
21x83	7,435	99894 T	83092 T	
21x111	8,165			
24x55	2,720	56765 C	39,281 C	
24x68	3,650	89996 T	74872 T	
24x76	4,930	–	85578 T	
24x104	6,000	–	–	
27x84	4,370			
27x94	5,920	–	–	
30x99	4,790			
30x108	6,160	–	–	
33x118	5,840	–	–	
36x135	6,655			●
36x150	9,425			
36x230	16,930	–	–	

* Recommended Lower Flange Loading per pair of wheels.

Lower flange loadings tabulated below are based on static load and do not consider service. Spacing between wheel centers must be equal to or greater than total flange width. All loading figures shown are in pounds.

	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60
Span in feet																								
	968 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1726 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1290 C	961 C	733 C	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	3794 D	2845 D	2188 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	5076 D	3807 D	2928 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6751 D	5066 D	3899 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1479 C	1100 C	837 C	646 C	501 C	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	7340 D	5547 D	4309 D	3416 D	2748 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	10564 D	7979 D	6194 D	4905 D	3941 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	16935 D	12804 D	9953 D	7896 D	6358 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1802 C	1343 C	1023 C	791 C	615 C	478 C	369 C	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	11281 C	8568 C	6700 C	5357 C	4356 C	3588 C	2985 C	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	19439 D	14751 D	11521 D	9197 D	7464 D	6134 D	5088 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	26667 D	20242 D	15816 D	12632 D	10258 D	8437 D	7005 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	33456 D	25400 D	19852 D	15860 D	12885 D	10603 D	8809 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	5858 C	4427 C	3439 C	2726 C	2193 C	1782 C	1457 C	1195 C	979 C	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	13162 C	9998 C	7819 C	6252 C	5085 C	4190 C	3487 C	2923 C	2462 C	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	25970 T	20488 D	16044 D	12850 D	10473 D	8652 D	7223 D	6078 D	5144 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	38205 T	30670 D	24029 D	19257 D	15706 D	12987 D	10854 D	9146 D	7754 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	50963 T	42288 D	33138 D	26564 D	21673 D	17929 D	14992 D	12641 D	10724 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	59287 T	47926 D	37566 D	30124 D	24588 D	20351 D	17028 D	14368 D	12201 D	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	7713 C	5837 C	4542 C	3609 C	2911 C	2375 C	1951 C	1610 C	1329 C	1095 C	897 C	–	–	–	–	–	–	–	–	–	–	–	–	–
	17948 C	13646 C	10686 C	8558 C	6974 C	5761 C	4809 C	4046 C	3423 C	2907 C	2474 C	–	–	–	–	–	–	–	–	–	–	–	–	–
	38233 T	33347 T	28631 D	22998 D	18811 D	15610 D	13103 D	11099 D	9469 D	8122 D	6993 D	–	–	–	–	–	–	–	–	–	–	–	–	–
	64322 T	56115 T	49201 D	39552 D	32383 D	26904 D	22615 D	19189 D	16404 D	14104 D	12179 D	–	–	–	–	–	–	–	–	–	–	–	–	–
	13868 C	10525 C	8222 C	6565 C	5330 C	4382 C	3637 C	3038 C	2548 C	2141 C	1798 C	1504 C	1250 C	–	–	–	–	–	–	–	–	–	–	–
	26881 C	20460 C	16042 C	12870 C	10510 C	8705 C	7289 C	6157 C	5234 C	4471 C	3830 C	3286 C	2818 C	–	–	–	–	–	–	–	–	–	–	–
	48568 T	42375 T	36753 C	29594 C	24280 C	20222 C	17050 C	14520 C	12466 C	10774 C	9360 C	8164 C	7142 C	–	–	–	–	–	–	–	–	–	–	–
	78093 T	68150 T	60394 T	53528 D	43906 D	36559 D	30814 D	26231 D	22510 D	19443 D	16880 D	14712 D	12859 D	–	–	–	–	–	–	–	–	–	–	–
	19340 C	14691 C	11490 C	9187 C	7472 C	6158 C	5125 C	4296 C	3619 C	3056 C	2583 C	2179 C	1831 C	1527 C	1259 C	1021 C	–	–	–	–	–	–	–	–
	37795 C	28786 C	22592 C	18145 C	14840 C	12312 C	10333 C	8750 C	7463 C	6398 C	5507 C	4750 C	4101 C	3539 C	3047 C	2612 C	–	–	–	–	–	–	–	–
	71068 T	62029 T	54980 T	45557 C	37423 C	31217 C	26369 C	22505 C	19371 C	16792 C	14640 C	12823 C	11272 C	9937 C	8775 C	7758 C	–	–	–	–	–	–	–	–
	–	90402 T	80147 T	71922 T	65171 T	56333 D	47615 D	40668 D	35037 D	30404 D	26540 D	23279 D	20499 D	18104 D	16024 D	14203 D	–	–	–	–	–	–	–	–
	28717 C	21841 C	17110 C	13710 C	11180 C	9243 C	7723 C	6505 C	5513 C	4690 C	3999 C	3411 C	2905 C	2465 C	2078 C	1736 C	1430 C	1155 C	906 C	–	–	–	–	–
	57412 C	43777 C	34407 C	27685 C	22694 C	18882 C	15900 C	13520 C	11587 C	9992 C	8659 C	7530 C	6565 C	5731 C	5004 C	4364 C	3798 C	3292 C	2838 C	–	–	–	–	–
	73212 T	57958 C	45590 C	36722 C	30141 C	25117 C	21191 C	18059 C	15518 C	13425 C	11677 C	10200 C	8939 C	7850 C	6903 C	6072 C	5337 C	4683 C	4097 C	–	–	–	–	–
	–	93757 T	83143 T	74631 T	67648 T	58089 C	49207 C	42139 C	36416 C	31713 C	27798 C	24500 C	21693 C	19281 C	17191 C	15366 C	13760 C	12338 C	11071 C	–	–	–	–	–
	85857 C	65512 C	51538 C	41518 C	34082 C	28407 C	23972 C	20435 C	17566 C	15202 C	13229 C	11561 C	10137 C	8909 C	7841 C	6903 C	6075 C	5338 C	4677 C	4082 C	3542 C	3050 C	–	–
	–	86730 C	68275 C	55048 C	45237 C	37753 C	31907 C	27249 C	23473 C	20366 C	17775 C	15588 C	13723 C	12117 C	10722 C	9500 C	8422 C	7464 C	6608 C	5838 C	5142 C	4509 C	–	–
	–	81924 C	64464 C	51948 C	42661 C	35574 C	30037 C	25623 C	22043 C	19095 C	16634 C	14557 C	12783 C	11254 C	9925 C	8759 C	7730 C	6814 C	5995 C	5257 C	4588 C	3980 C	3423 C	2912 C
	–	–	81123 C	65417 C	53768 C	44882 C	37943 C	32415 C	27934 C	24247 C	21173 C	18580 C	16368 C	14464 C	12811 C	11363 C	10086 C	8952 C	7939 C	7029 C	6205 C	5458 C	4775 C	4148 C
	–	–	94420 C	76161 C	62620 C	52293 C	44230 C	37807 C	32603 C	28323 C	24755 C	21746 C	19182 C	16975 C	15059 C	13383 C	11906 C	10595 C	9424 C	8373 C	7423 C	6561 C	5774 C	5053 C
	–	–	–	95794 C	78799 C	65841 C	55726 C	47673 C	41150 C	35787 C	31319 C	27552 C	24344 C	21586 C	19193 C	17101 C	15258 C	13625 C	12168 C	10860 C	9680 C	8611 C	7636 C	6743 C
	–	–	–	–	89776 C	76079 C	65180 C	56358 C	49111 C	43079 C	38000 C	33679 C	29967 C	26752 C	23946 C	21478 C	19294 C	17349 C	15607 C	14039 C	12620 C	11330 C	10152 C	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	96197 C	86596 C	78243 C	70927 C	64478 C	58760 C	53663 C	49097 C	44987 C	41271 C	37899 C

Limits T = Tension   C = Compression   D = Vertical Defl.   L = Lateral Defl.

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W SHAPES WITH CAPPING CHANNEL
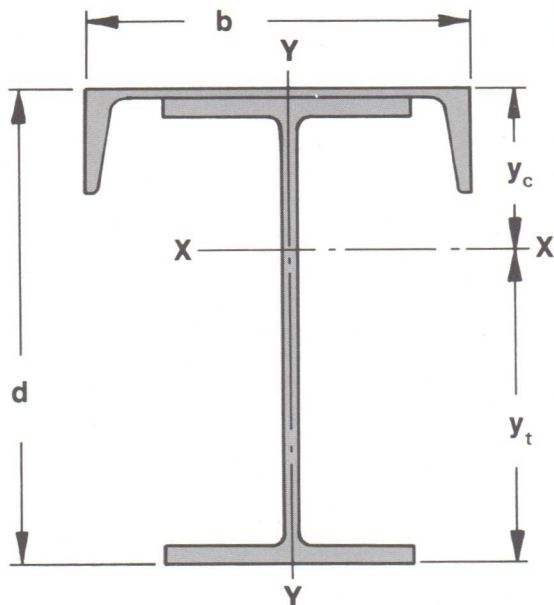
Beam Loading

W Shape	Channel	Span in feet							
		10	12	14	16	18	20	22	24
8x18	10x15.3	9700 T	8022 T	5895 D	4403 D	3368 D	-	-	-
8x24	10x15.3	12972 T	10142 T	7324 D	5478 D	4196 D	-	-	-
8x31	10x15.3	16885 T	12809 D	9261 D	6937 D	5326 D	-	-	
10x22	10x15.3	14777 T	12246 T	10427 T	8360 D	6480 D	5123 D	4106 D	
10x22	12x20.7	14991 T	12414 T	10561 T	8877 T	6871 D	5421 D	4334 D	
10x33	10x15.3	21586 T	17900 T	14493 T	10936 D	8479 D	6705 D	5376 D	
10x33	12x20.7	21834 T	18097 T	15359 D	11582 D	8971 D	7085 D	5671 D	
12x26	10x15.3	21099 T	17506 T	14929 T	12985 T	11071 T	8827 D	7154 D	5869 D
12x26	12x20.7	21359 T	17714 T	15096 T	13122 T	11575 T	9357 D	7573 D	6203 D
12x40	10x15.3	32027 T	26588 T	22687 T	19652 T	15342 D	12240 D	9926 D	8150 D
12x40	12x20.7	32364 T	26859 T	22909 T	19931 T	16223 D	12935 D	10483 D	8599 D
14x30	10x15.3	26804 T	22253 T	18990 T	16531 T	14609 T	12575 D	10238 D	8447 D
14x30	12x20.7	27170 T	22549 T	19233 T	16734 T	14779 T	13205 T	10871 D	8960 D
14x30	15x33.9	27890 T	23124 T	19702 T	17120 T	15097 T	13466 T	12024 D	9883 D
14x43	12x20.7	39189 T	32540 T	27774 T	24182 T	21375 T	17996 D	14655 D	12095 D
14x43	15x33.9	40061 T	33243 T	28352 T	24663 T	21778 T	19454 T	16186 D	13336 D
14x61	15x33.9	57827 T	48015 T	40980 T	35680 T	31536 T	27696 T	22565 D	18633 D
14x82	15x33.9	77315 T	64217 T	54827 T	47757 T	42231 T	36492 D	29762 D	24609 D
16x36	10x15.3	36042 T	29941 T	25568 T	22276 T	19704 T	17636 T	15565 D	12902 D
16x36	12x20.7	36560 T	30363 T	25920 T	22574 T	19959 T	17855 T	16123 T	13709 D
16x36	15x33.9	37545 T	31159 T	26578 T	23125 T	20423 T	18248 T	16456 T	14950 T
16x57	12x20.7	58541 T	48642 T	41549 T	36209 T	32039 T	28688 T	25655 D	21290 D
16x57	15x33.9	60123 T	49936 T	42634 T	37134 T	32836 T	29380 T	26535 T	23601 D
16x89	15x33.9	97488 T	81015 T	69213 T	60331 T	53395 T	47822 T	43240 T	36574 D
18x46	10x15.3	50334 T	41833 T	35743 T	31160 T	27582 T	24707 T	22344 T	20055 D
18x46	12x20.7	51135 T	42490 T	36296 T	31634 T	27993 T	25067 T	22661 T	20644 T
18x46	15x33.9	52641 T	43721 T	37326 T	32511 T	28748 T	25721 T	23230 T	21141 T
18x65	12x20.7	73753 T	61303 T	52387 T	45678 T	40440 T	36233 T	32776 T	29737 D
18x65	15x33.9	75734 T	62930 T	53756 T	46851 T	41459 T	37125 T	33561 T	30575 T
18x97	15x33.9	-	97968 T	83730 T	73018 T	64658 T	57943 T	52426 T	47806 T
21x57	12x20.7	71880 T	59758 T	51077 T	44546 T	39450 T	35357 T	31995 T	29179 T
21x57	15x33.9	74102 T	61585 T	52618 T	45870 T	40602 T	36369 T	32889 T	29974 T
21x83	12x20.7	-	89289 T	76340 T	66603 T	59007 T	52909 T	47901 T	43711 T
21x83	15x33.9	-	91653 T	78343 T	68331 T	60518 T	54244 T	49089 T	44774 T
21x111	18x42.7	-	-	-	97088 T	86010 T	77117 T	69813 T	63700 T
24x68	12x20.7	98345 T	81792 T	69943 T	61033 T	54084 T	48507 T	43928 T	40097 T
24x68	15x33.9	-	84113 T	71907 T	62728 T	55566 T	49815 T	45092 T	41139 T
24x68	18x42.7	-	85184 T	72810 T	63501 T	56236 T	50402 T	45609 T	41596 T
24x76	15x33.9	-	94814 T	81065 T	70726 T	62660 T	56185 T	50867 T	46418 T
24x104	15x33.9	-	-	-	-	89085 T	79915 T	72386 T	66090 T
24x104	18x42.7	-	-	-	-	89928 T	80657 T	73044 T	66676 T
27x84	15x33.9	-	-	98658 T	86104 T	76314 T	68459 T	62010 T	56617 T
27x84	18x42.7	-	-	99920 T	87192 T	77265 T	69298 T	62756 T	57283 T
27x94	15x33.9	-	-	-	97155 T	86118 T	77263 T	69995 T	63917 T
30x99	15x33.9	-	-	-	-	96443 T	86546 T	78425 T	71635 T
30x99	18x42.7	-	-	-	-	97759 T	87714 T	79469 T	72575 T
30x108	15x33.9	-	-	-	-	-	95525 T	86570 T	79084 T
33x118	15x33.9	-	-	-	-	-	-	-	94682 T
33x118	18x42.7	-	-	-	-	-	-	-	95889 T
36x135	15x33.9	-	-	-	-	-	-	-	-
36x135	18x42.7	-	-	-	-	-	-	-	-

All loading figures shown are in pounds.

	Span in feet																	
	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4858 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5123 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6753 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7116 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7040 D	5912 D	4991 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7458 D	6254 D	5270 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	8200 T	6847 D	5740 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10084 D	8473 D	7158 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11096 D	9300 D	7831 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15548 D	13075 D	11057 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20567 D	17329 D	14689 D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10816 D	9147 D	7788 D	6664 D	5722 D	-	-	-	-	-	-	-	-	-	-	-	-	-
	11484 D	9704 D	8255 D	7055 D	6049 D	-	-	-	-	-	-	-	-	-	-	-	-	-
	12714 D	10719 D	9092 D	7745 D	6614 D	-	-	-	-	-	-	-	-	-	-	-	-	-
	17871 D	15138 D	12914 D	11077 D	9537 D	-	-	-	-	-	-	-	-	-	-	-	-	-
	19795 D	16751 D	14273 D	12225 D	10507 D	-	-	-	-	-	-	-	-	-	-	-	-	-
	30738 D	26075 D	22283 D	19152 D	16531 D	-	-	-	-	-	-	-	-	-	-	-	-	-
	16875 D	14337 D	12274 D	10572 D	9148 D	7942 D	6910 D	-	-	-	-	-	-	-	-	-	-	-
	17930 D	15227 D	13031 D	11218 D	9701 D	8417 D	7317 D	-	-	-	-	-	-	-	-	-	-	-
	19361 T	16927 D	14465 D	12432 D	10730 D	9288 D	8052 D	-	-	-	-	-	-	-	-	-	-	-
	25041 D	21292 D	18247 D	15736 D	13636 D	11859 D	10339 D	-	-	-	-	-	-	-	-	-	-	-
	27705 D	23544 D	20162 D	17372 D	15039 D	13064 D	11373 D	-	-	-	-	-	-	-	-	-	-	-
	41254 D	35114 D	30129 D	26020 D	22586 D	19682 D	17199 D	-	-	-	-	-	-	-	-	-	-	-
	26785 T	24659 D	21209 D	18367 D	15995 D	13992 D	12281 D	10807 D	9524 D	8400 D	-	-	-	-	-	-	-	-
	27494 T	25355 T	23488 D	20420 D	17767 D	15525 D	13611 D	11960 D	10523 D	9262 D	-	-	-	-	-	-	-	-
	40149 T	35695 D	30731 D	26645 D	23236 D	20358 D	17903 D	15787 D	13949 D	12338 D	-	-	-	-	-	-	-	-
	41105 T	37944 D	33838 D	29329 D	25567 D	22390 D	19680 D	17344 D	15314 D	13534 D	-	-	-	-	-	-	-	-
	58505 T	54029 D	47925 D	41580 D	36289 D	31824 D	28015 D	24736 D	21887 D	19392 D	-	-	-	-	-	-	-	-
	36842 T	34040 T	31599 T	28119 D	24595 D	21623 D	19092 D	16914 D	15024 D	13372 D	11916 D	10625 D	9472 D	-	-	-	-	-
	37779 T	34884 T	32361 T	30141 T	27226 D	23923 D	21109 D	18688 D	16586 D	14747 D	13127 D	11689 D	10406 D	-	-	-	-	-
	38183 T	35242 T	32679 T	30422 T	28417 D	25098 D	22132 D	19579 D	17363 D	15424 D	13714 D	12197 D	10842 D	-	-	-	-	-
	42636 T	39378 T	36541 T	34044 T	30476 D	26794 D	23657 D	20959 D	18617 D	16570 D	14766 D	13166 D	11737 D	-	-	-	-	-
	60741 T	56136 T	52127 T	47665 D	41735 D	36738 D	32482 D	28823 D	25651 D	22878 D	20437 D	18273 D	16344 D	-	-	-	-	-
	61265 T	56606 T	52548 T	48980 T	43596 D	38367 D	33913 D	30083 D	26762 D	23859 D	21303 D	19037 D	17016 D	-	-	-	-	-
	52035 T	48091 T	44657 T	41637 T	38959 T	36477 D	32319 D	28748 D	25654 D	22952 D	20577 D	18474 D	16600 D	14923 D	13412 D	12044 D	-	-
	52633 T	48629 T	45143 T	42076 T	39355 T	36922 D	33910 D	30152 D	26896 D	24052 D	21551 D	19337 D	17365 D	15598 D	14006 D	12565 D	-	-
	58754 T	54311 T	50433 T	47043 T	44027 T	40857 D	36215 D	32228 D	28774 D	25760 D	23109 D	20764 D	18675 D	16805 D	15121 D	13597 D	-	-
	65869 T	60907 T	56590 T	52796 T	49432 T	46427 T	43725 D	40039 D	35841 D	32181 D	28966 D	26125 D	23598 D	21338 D	19307 D	17471 D	15806 D	14288 D
	66720 T	61681 T	57295 T	53439 T	50021 T	46966 T	44218 T	41731 T	37612 D	33763 D	30382 D	27393 D	24735 D	22358 D	20221 D	18289 D	16536 D	14939 D
	72728 T	67259 T	62501 T	58320 T	54613 T	51303 T	48327 T	43980 D	39384 D	35458 D	31858 D	28748 D	25983 D	23511 D	21289 D	19282 D	17461 D	15802 D
	87107 T	80592 T	74926 T	69948 T	65539 T	61602 T	58064 T	54865 T	51956 T	46878 T	42345 D	38344 D	34790 D	31618 D	28770 D	26202 D	23876 D	21760 D
	88204 T	81594 T	75844 T	70792 T	66316 T	62319 T	58726 T	55476 T	52521 T	49103 T	44349 D	40153 D	36426 D	33098 D	30111 D	27417 D	24977 D	22757 D
	-	98291 T	91412 T	85372 T	80022 T	75248 T	70958 T	67081 T	63557 T	60338 T	55239 C	50246 C	45820 C	41780 D	38132 D	34846 D	31872 D	29170 D
	-	99551 T	92571 T	86441 T	81011 T	76165 T	71810 T	67873 T	64294 T	61024 T	58023 T	52737 D	47962 D	43703 D	39883 D	36442 D	33329 D	30499 D

Limits T = Tension C = Compression D = Vertical Defl. L = Lateral Defl.

15

W SHAPES WITH CAPPING CHANNEL

Theoretical
Dimensions and Properties

W Shape	Channel	Total Weight per Foot lb.	Total Area in²	Width b in.	Depth d in.	Yc in.	Yt in.	Axis X-X I in.⁴	Axis X-X Sc Upper in.³	Axis X-X St Lower in.³	Axis Y-Y I in.⁴	Axis Y-Y S in.³
8x18	10x15.3	33.3	9.75	10.0	8.380	2.617	5.763	96.91	37.03	16.82	75.37	15.07
8x24	10x15.3	39.3	11.57	10.0	8.170	2.819	5.351	120.1	42.61	22.45	85.7	17.14
8x31	10x15.3	46.3	13.62	10.0	8.240	3.051	5.189	151.4	49.63	29.18	104.5	20.90
10x22	10x15.3	37.3	10.98	10.0	10.410	3.407	7.003	178.7	52.44	25.51	78.8	15.76
10x22	12x20.7	42.7	12.58	12.0	10.452	3.107	7.345	190.4	61.27	25.92	140.4	23.40
10x33	10x15.3	48.3	14.20	10.0	9.970	3.691	6.279	233.6	63.30	37.21	104.0	20.80
10x33	12x20.7	53.7	15.80	12.0	10.012	3.432	6.580	247.9	72.25	37.68	165.6	27.60
12x26	10x15.3	41.3	12.14	10.0	12.460	4.236	8.224	298.7	70.52	36.32	84.7	16.94
12x26	12x20.7	46.7	13.74	12.0	12.502	3.868	8.634	317.8	82.16	36.81	146.3	24.38
12x40	10x15.3	55.3	16.29	10.0	12.180	4.673	7.507	413.4	88.46	55.07	111.5	22.30
12x40	12x20.7	60.7	17.89	12.0	12.222	4.361	7.861	437.8	100.4	55.69	173.1	28.85
14x30	10x15.3	45.3	13.34	10.0	14.080	4.963	9.117	420.1	84.65	46.08	87.0	17.40
14x30	12x20.7	50.7	14.94	12.0	14.122	4.551	9.571	447.5	98.33	46.75	148.6	24.77
14x30	15x33.9	63.9	18.81	15.0	14.240	3.861	10.379	499.1	129.3	48.09	334.6	44.61
14x43	12x20.7	63.7	18.69	12.0	13.942	5.022	8.920	600.8	119.6	67.35	174.2	29.03
14x43	15x33.9	76.9	22.56	15.0	14.060	4.385	9.675	667.1	152.1	68.95	360.2	48.03
14x61	15x33.9	94.9	27.86	15.0	14.290	5.000	9.290	923.3	184.7	99.39	422.0	56.27
14x82	15x33.9	115.9	34.06	15.0	14.710	5.576	9.134	1213	217.5	132.8	463.0	61.73
16x36	10x15.3	51.3	15.09	10.0	16.100	5.928	10.172	629.4	106.2	61.88	91.9	18.38
16x36	12x20.7	56.7	16.69	12.0	16.142	5.470	10.672	670.3	122.3	62.81	153.5	25.58
16x36	15x33.9	69.9	20.56	15.0	16.260	4.676	11.584	748.3	160.0	64.60	339.5	45.27
16x57	12x20.7	77.7	22.89	12.0	16.712	6.422	10.290	1034	161.0	100.5	172.1	28.68
16x57	15x33.9	90.9	26.76	15.0	16.830	5.701	11.129	1149	201.6	103.3	358.1	47.75
16x89	15x33.9	122.9	36.16	15.0	17.150	6.575	10.575	1769	269.0	167.2	478.0	63.73
18x46	10x15.3	61.3	17.99	10.0	18.300	7.115	11.185	965.6	135.7	86.33	89.9	17.98
18x46	12x20.7	66.7	19.59	12.0	18.342	6.634	11.708	1027	154.8	87.74	151.5	25.25
18x46	15x33.9	79.9	23.46	15.0	18.460	5.761	12.699	1148	199.3	90.42	337.5	45.00
18x65	12x20.7	85.7	25.19	12.0	18.632	7.339	11.293	1428	194.6	126.5	183.8	30.63
18x65	15x33.9	98.9	29.06	15.0	18.750	6.563	12.187	1584	241.3	130.0	369.8	49.31
18x97	15x33.9	130.9	38.46	15.0	18.990	7.388	11.602	2344	317.2	202.0	516.0	68.80
21x57	12x20.7	77.7	22.79	12.0	21.342	8.109	13.233	1630	201.1	123.2	159.6	26.60
21x57	15x33.9	90.9	26.66	15.0	21.460	7.141	14.319	1820	254.9	127.1	345.6	46.08
21x83	12x20.7	103.7	30.39	12.0	21.712	8.933	12.779	2350	263.1	183.9	210.4	35.07
21x83	15x33.9	116.9	34.26	15.0	21.830	8.112	13.718	2592	319.5	188.9	396.4	52.85
21x111	18x42.7	153.7	45.30	18.0	21.960	8.332	13.628	3655	438.6	268.2	828.0	92.00
24x68	12x20.7	88.7	26.19	12.0	24.012	9.485	14.527	2447	257.9	168.4	199.4	33.23
24x68	15x33.9	101.9	30.06	15.0	24.13	8.462	15.668	2716	320.9	173.3	385.4	51.39
24x68	18x42.7	110.7	32.70	18.0	24.18	7.908	16.272	2858	361.4	175.6	624.4	69.38
24x76	15x33.9	109.9	32.36	15.0	24.32	8.798	15.522	3032	344.6	195.3	397.5	53.00
24x104	15x33.9	137.9	40.56	15.0	24.46	9.571	14.889	4127	431.2	277.2	574	76.53
24x104	18x42.7	146.7	43.20	18.0	24.51	9.096	15.414	4316	474.5	280.0	813	90.33
27x84	15x33.9	117.9	34.76	15.0	27.11	10.039	17.071	4053	403.7	237.4	421	56.13
27x84	18x42.7	126.7	37.40	18.0	27.16	9.450	17.710	4261	450.9	240.6	660	73.33
27x94	15x33.9	127.9	37.66	15.0	27.32	10.403	16.917	4530	435.5	267.8	439	58.53
30x99	15x33.9	132.9	39.06	15.0	30.05	11.543	18.507	5545	480.4	299.6	443	59.07
30x99	18x42.7	141.7	41.70	18.0	30.10	10.925	19.175	5827	533.4	303.9	682	75.78
30x108	15x33.9	141.9	41.66	15.0	30.23	11.842	18.388	6078	513.2	330.5	461	61.47
33x118	15x33.9	151.9	44.66	15.0	33.26	13.252	20.008	7900	596.1	394.8	502	66.93
33x118	18x42.7	160.7	47.30	18.0	33.31	12.617	20.693	8282	656.4	400.2	741	82.33
36x135	15x33.9	168.9	49.66	15.0	35.95	14.688	21.262	10215	695.5	480.5	540	72.00
36x135	18x42.7	177.7	52.30	18.0	36.00	14.046	21.954	10693	761.3	487.1	779	86.56

NOTES: Refer to page 12; **REFERENCES:** Refer to page 5.

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